# INSTRUCTION MANUAL

TYPE RM546

MOD 237L

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

# INSTRUCTION MANUAL

Serial Number 1506

MODIFICATION INSERT

TYPE RM546
MOD 237L

This manual insert describes the features of MOD 237L as installed in the Type RM546 Oscilloscope. The instrument is modified by replacing the standard 8" polished rod-type handles with 9" oval satin finish handles.

## PARTS LIST

The following changes should be made to the appropriate parts list for this modified instrument. When ordering replacement parts, specify instrument type, serial number, and MOD number. Include the part number and description of the desired item.

*Parts identified by an asterisk are unique to this modified product and are not normally stocked.

| | | | |
|---|---|---|---|
| PANEL, front, film #4073 | Change | 1 | *034-0263-00 |
| HANDLE, Cambridge Thermionic CP-2111-4-2301 | Change | 2 | *036-3084-00 |

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TYPE RM546

MOD 237L

Tektronix, Inc.
S.W. Millikan Way • P. O. Box 500 • Beaverton, Oregon 97005 • Phone 644-0161 • Cables: Tektronix

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# INSTRUCTION MANUAL

Serial Number _____

## TYPE RM546 OSCILLOSCOPE

*Tektronix, Inc.*
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-421

# WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

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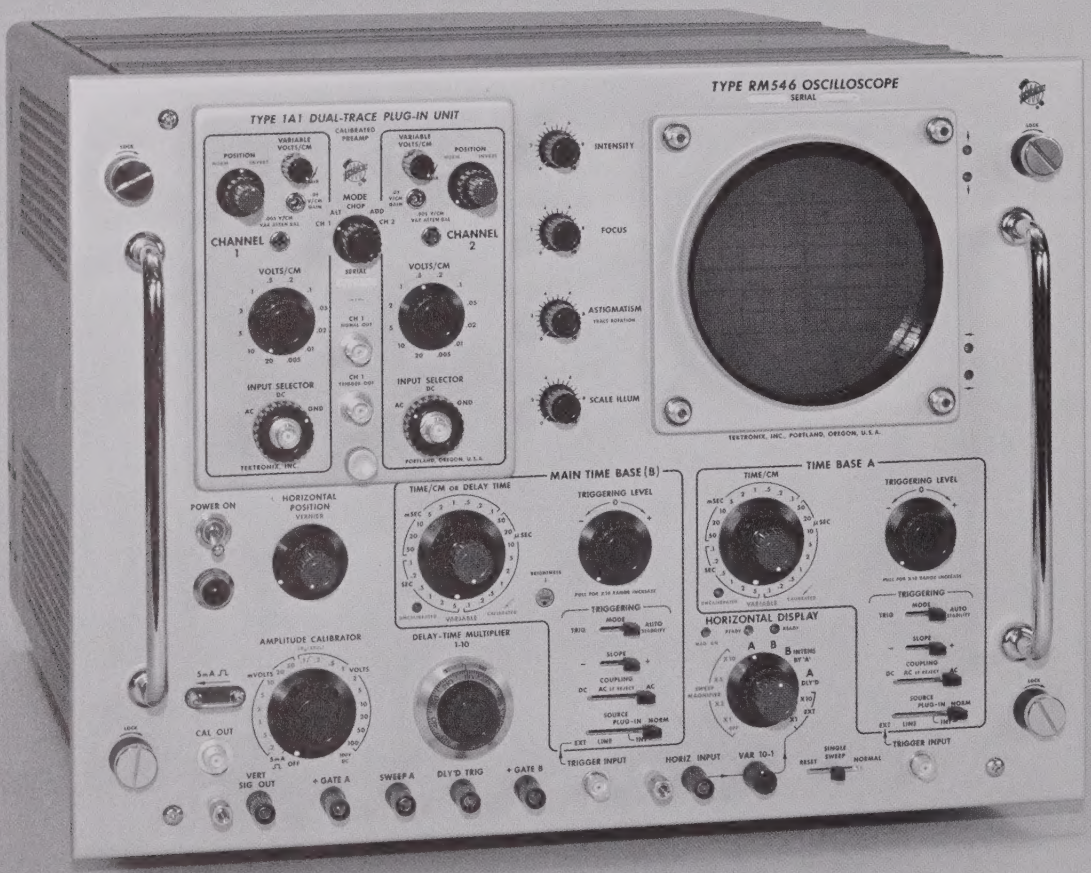
A list of abbreviations and symbols used in this manual will be found on page 6-1. Change information, if any, is located at the rear of the manual.


TYPE RM546 OSCILLOSCOPE
SERIAL
TYPE 1A1 DUAL-TRACE PLUG-IN UNIT
CALIBRATED PREAMP
CHANNEL 1
CHANNEL 2
VOLTS/CM
INPUT SELECTOR
MODE
CHOP
ALT
ADD
INTENSITY
FOCUS
ASTIGMATISM
SCALE ILLUM
TEKTRONIX, INC., PORTLAND, OREGON, U.S.A.
MAIN TIME BASE (B)
TIME/CM OR DELAY TIME
TRIGGERING LEVEL
TRIGGERING
TIME BASE A
TIME/CM
HORIZONTAL DISPLAY
POWER ON
HORIZONTAL POSITION
AMPLITUDE CALIBRATOR
CAL OUT
DELAY-TIME MULTIPLIER
1-10
VERT SIG OUT
+ GATE A
SWEEP A
DLY'D TRIG
+ GATE B
TRIGGER INPUT
HORIZ INPUT
VAR 10-1
SINGLE SWEEP
RESET
NORMAL

# SECTION 1

# CHARACTERISTICS

## Introduction

The Type 546 Oscilloscope is a versatile laboratory instrument designed for use with all Tektronix letter-series plug-in units. The instrument features two identical time-base generators. The two time-base generators can be used singly or in "delaying" and "delayed" sweep operation for highly accurate time-differential measurements.

## Vertical Deflection System

The plug-in unit and probe used with the Type 546 determine the overall characteristics of the vertical deflection system. Refer to Table 1-1 for the characteristics.

## Sweep Generation

Trigger features and sweep rates of both Type 546 time-base circuits are identical.

| | |
|---|---|
| Sweep Rates (at 1X magnification) | 0.1 μsecond/cm to 5 seconds/cm in 24 calibrated steps. Displayed sweep-rate accuracy is ±2% for both sweeps. An uncalibrated variable control of sweep rate permits either sweep to be slowed to no more than 40% of the indicated rate. |
| Sweep Magnification | Any sweep rate can be increased by horizontal expansion of the center portion of the display in fixed steps of 2X, 5X, and 10X. Sweep-rate accuracy is within 5%. |
| Trigger Source Selection | Internal, internal plug-in, external and line. |
| Trigger Coupling Selection | Dc, ac and ac low-frequency rejection. |
| Trigger Signal Requirements | Internal (ac): Minimum deflection is 2 mm, rising to 1 cm at about 50 mc.<br>Internal (dc): Minimum deflection is 5 mm.<br>Internal (ac low-frequency rejection): Minimum deflection is 2 mm with signals at about 2 kc, rising to 1 cm at about 50 mc.<br>External: Frequency ranges are the same as internal. Minimum amplitude is: 200 mvolts, peak-to-peak, (ac), 200 mvolts, change in dc level (dc) and, 200 mvolts peak-to-peak (ac low-frequency reject). |

**TABLE 1-1**

**PLUG-IN CHARACTERISTICS FOR THE TYPE 546 OSCILLOSCOPE**

| PLUG-IN UNIT | CALIBRATED DEFLECTION FACTOR | BANDPASS | RISETIME | INPUT CAPACITANCE |
|---|---|---|---|---|
| Type 1A1** | 50 mv/cm to 20 v/cm<br>5 mv/cm | dc to 50 mc<br>dc to 28 mc | 7 nsec<br>12.5 nsec | 15 pf |
| Type 1A2 | 50 mv/cm to 20 v/cm | dc to 50 mc | 7 nsec | 15 pf |
| Type 1A7 | 10 mv/cm to 10 v/cm | dc to 100 cps-500 kc | .7 μsec | 47 pf |
| Type 1S1 | 2 mv/cm to 200 mv/cm | dc to 1000 mc | .35 nsec | 50 ohm input Z |
| Type B | 5 mv/cm to 0.02 v/cm<br>0.05 v/cm to 20 v/cm | 2 cps to 12 mc<br>dc to 20 mc | 30 nsec<br>18 nsec | 47 pf |
| Type CA** | 0.05 v/cm to 20 v/cm | dc to 24 mc | 15 nsec | 20 pf |
| Type D | 1mv/cm to 50 v/cm | dc to 300 kc-2 mc | 0.18 μsec | 47 pf |
| Type E | 50 μv/cm to 10 mv/cm | 0.06 cps to 20 kc-60 kc | 6 μsec | 50 pf |
| Type G | 0.05 v/cm to 20 v/cm | dc to 20 mc | 18 nsec | 47 pf |
| Type H | 5 mv/cm to 20 v/cm | dc to 15 mc | 23 nsec | 47 pf |
| Type K | 0.05 v/cm to 20 v/cm | dc to 30 mc | 12 nsec | 20 pf |
| Type L | 5 mv/cm to 2 v/cm<br>0.05 v/cm to 20 v/cm | 3 cps to 24 mc<br>dc to 30 mc | 15 nsec<br>12 nsec | 20 pf |
| Type M** | 0.02 v/cm to 10 v/cm | dc to 20 mc | 18 nsec | 47 pf |
| Type O* | 0.05 v/cm to 20 v/cm | dc to 25 mc | 14 nsec | 47 pf |
| Type Q* | 10 μstrain/cm to 10,000 μstrain/cm | dc to 6 kc | 60 μsec | Adjustable |
| Type R* | 0.5 ma/cm to 100 ma/cm | | | |
| Type S* | 0.05 v/cm and 0.5 v/cm | | | |
| Type W | 1 mv/cm to 50 v/cm | dc to 8 mc<br>dc to 23 mc | 44 nsec<br>15 nsec | 20 pf |
| Type Z* | 0.05 v/cm to 25 v/cm | dc to 13 mc | 27 nsec | 24 pf |

***Special feature plug-in units—see your Tektronix catalog for more information on any of the plug-in units.**
****Multiple-trace plug-in units.**

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A MAXIMUM INPUT OF ±30 VOLTS must not be exceeded in the EXTERNAL trigger position.

Maximum trigger level range is greater than ±2 volts with the TRIGGERING LEVEL control pushed in and ±20 volts with the control pulled out.

Sweep Delay — The Time-Base A sweep can be delayed by the Main Time Base (B) sweep. Delay is continuously variable over the range of 0.1 μsec to 50 sec with the DELAY TIME and DELAY-TIME MULTIPLIER controls. Delay time is accurate to ±1% of indicated delay ±2 minor divisions of the DELAY-TIME MULTIPLIER at sweep rates from 50 μsec to 50 sec. At delay times shorter than 50 μsec, indicated delay accuracy is the same as above plus approximately 75-100 nsec. The 75-100 nsec represents the fixed inherent delay of the internal trigger circuitry of the Type 546. Incremental delay accuracy is ±2 minor divisions of the DELAY-TIME MULTIPLIER dial at sweep rates from 1 μsec to 50 sec. Incremental accuracy at the three fastest sweep rates (.1, .2, and .5 μsec) is ±5 minor divisions. Stated accuracies apply only when the VARIABLE controls are set to CALIB. Delay jitter is no greater than 1 part in 20,000.

## Horizontal Deflection System

The following characteristics apply when the HORIZONTAL DISPLAY switch is set to the EXT positions.

| | |
|---|---|
| Deflection Factor | 0.1 volt/cm to approximately 10 volt/cm; continuously adjustable. |
| Frequency Response | Dc to 400 kc (3-db down frequency). |
| Input Characteristics | 1 megohm paralleled by approximately 55 pf. |

## Amplitude Calibrator

| | |
|---|---|
| Output Voltages | 0.2 millivolts to 100 volts, peak-to-peak, in 18 steps. In addition, a 100-volt dc output is available. |
| Frequency | Approximately 1-kc square wave. |
| Risetime | .2 mv-5 volts; .5 μsec or faster. 10-100 volts; 1 μsec or faster. |
| Output Current | 5 milliampere, 1-kc square wave available at the front-panel current loop. |
| Output Impedance | 50 Ω in 0.2 to 200-millivolt positions. Progressively higher output impedances in the .5- to 50-volt positions up to about 4 kΩ in the 50-volt position. Output impedance of the 100-volt positions (ac and dc) is about 420 Ω. |
| Amplitude Accuracy | Peak-to-peak amplitude accuracy is within ±3% of indicated when working into an impedance of 1 megohm. The .2 to 200 mVolts position will be within ±3% of one-half of the indicated voltage when working into an impedance of 50 ohms. Accuracy of the current in the current loop is ±3%. |

## Front-Panel Output Signals

| | |
|---|---|
| +GATE B | Approximately a 20-volt, peak-to-peak, square-wave pulse having the same duration as the B sweep. Minimum load impedance is 5 kΩ. |
| DLY'D TRIG | Approximately a 10-volt peak-to-peak pulse occurring at the end of the delay period. |
| SWEEP A | Approximately a 100-volt, peak-to-peak sawtooth voltage having the same duration as the A sweep. Minimum load impedance is 10 kΩ. |
| +GATE A | Approximately a 20-volt, peak-to-peak, square-wave pulse having the same duration as the A sweep. Minimum load impedance is 5 kΩ. |
| VERT SIG OUT | Vertical signal output connector. Output amplitude is approximately 0.4 volts per centimeter of deflection on the crt. Rise-time is 20 nsec or faster. Output is ac coupled. |
| External Single-Sweep Reset Input-Signal Requirements | Requires a positive going step or pulse of at least +20 volts with a risetime of 0.5 μsec or faster. |

## Cathode Ray Tube

| | |
|---|---|
| Type | T5470-31-2 |
| Unblanking | Dc coupled |
| Accelerating Potential | 10 kv |
| Deflection System | Electrostatic |
| Useable Viewing Area | 6 cm high by 10 cm wide |
| Focus | Vertical: 2 horizontal lines/mm distinguishable over the center 4 cm. 1.5 horizontal lines/mm distinguishable in the top and bottom 1 cm.<br>Horizontal: 2 time markers/mm distinguishable over the middle 8 cm. 1.5 time markers/mm distinguishable in the first and tenth cm. |
| Construction | All glass, 5-inch, flat faced crt |
| Graticule | Internal; adjustable edge lighting. 6 x 10 cm; with vertical and horizontal 1-centimeter divisions with 2-millimeter markings on the center-lines. Provision made for risetime measurement. |

## Power Supplies

| | |
|---|---|
| Line Voltage | ±10% of nominal line voltage. (See Operating Instructions) |



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| | |
|---|---|
| Line Frequency | 50-60 and 400 cps*. |
| Power Consumption | About 510 watts |
| Overload Protection | Primary of power transformer is fused and a thermal relay is installed that interrupts power in the event of over-heating. |

***With line frequencies of 400 cps, a special fan modification is required; contact your local Tektronix Field representative.**

## Construction

| | |
|---|---|
| Cabinet | Blue vinyl covered, painted aluminum. aluminum. Front panel is anodized. Cabinet dimensions are 13″ (w) x 24″ (l) x 16¾″ (h). |
| Chassis | Aluminum alloy. |

## NOTES

# SECTION 2

# OPERATING INSTRUCTIONS

## FUNCTION OF EXTERNAL CONTROLS AND CONNECTORS

### Time Base A Controls

| | |
|---|---|
| TRIGGERING LEVEL | Selects the amplitude point on the triggering signal where sweep triggering occurs. When the knob is pulled out, greater triggering range is offered for triggering on higher amplitude trigger signals. With ac coupling, the triggering circuit is most sensitive with the TRIGGERING LEVEL control pushed in and set at 0. |
| TRIGGERING MODE | AUTO STABILITY permits normal triggering on signals with repetition rates higher than about 20 cps. With no trigger signal, or with a lower repetition rate, the time base circuit free runs and provides a handy reference trace. TRIG (triggered) permits normal triggering on all triggering signals. No trace occurs when the triggering signal is removed. |
| SLOPE | Determines whether the time base is triggered on the negative-(—) or positive-(+) going slope of the signal. |
| COUPLING | AC position blocks any dc component of the triggering signal and allows triggering to take place only on the changing portion of the signal. With frequencies below about 30 cps, use the DC position. AC LF REJ position rejects trigger signal frequencies below about 1.5 kc allowing the trigger circuits to respond to higher frequencies.<br>DC position permits triggering on both high- and low- (to dc) frequency signals. |
| SOURCE | NORM position uses a version of the signal applied to the vertical deflection plates of the crt as a trigger signal.<br>PLUG IN position applies to the Tektronix Type 1A1 plug-in unit when it is desired to trigger only on the Channel 1 signal.<br>LINE position uses the line frequency signal as a trigger.<br>EXT position is for external triggering on a signal applied to the TRIGGER INPUT connector. |
| TIME/CM | Selects the sweep rate of Time Base A. |
| VARIABLE | Provides an uncalibrated adjustment of sweep rate. The sweep rate can be slowed by a factor of at least 2.5X. An UNCALIBRATED lamp lights to warn when the VARIABLE control is not in the CALIBRATED position. |

### Main Time Base (B) Controls

All controls of the Main Time Base (B) serve the same function as the Time Base A controls with the exception of the following additional control.

| | |
|---|---|
| BRIGHTNESS | Allows adjustment of the contrast or brightness ratio of the B trace compared to the A trace. |
| HORIZONTAL DISPLAY | The A position allows only Time Base A to display on the crt.<br>The B position allows only the Main Time Base (B) to to display on the crt. B INTENS BY 'A' is one of the delayed sweep functions. In this position, a portion of the Main Time Base (B) is intensified during the time that Time Base A (the delayed sweep) is in operation.<br>A DLY'D is one of the delayed sweep functions. In this position Time Base A is displayed at the end of each delay period as determined by the B TIME/CM OR DELAY TIME and DELAY-TIME MULTIPLIER controls.<br>EXT X1 and X10 positions permit an external signal to be applied to the horizontal deflection circuit. Sensitivity is continuously variable (with the VAR 10-1 control). |
| READY LAMPS | These light when the corresponding time-base circuit is ready for triggering. |
| SWEEP MAGNIFIER | Expands the sweep from the center of the graticule at any given setting of the TIME/CM switch by the amount indicated. |
| SINGLE SWEEP | Permits single sweep operation in all modes of horizontal display except EXT. |
| DELAY-TIME MULTIPLIER 1-10 | Works in conjunction with the TIME/CM OR DELAY TIME control of the Main Time Base (B). Varies delay from 0.15× to 10.15× the time indicated by the Main Time Base (B) TIME/CM OR DELAY TIME switch. |
| HORIZONTAL POSITION VERNIER | Positions the display along the horizontal axis of the crt. |
| AMPLITUDE CALIBRATOR | Determines the peak-to-peak voltage at the CAL OUT connector. |
| 5 mA Current Loop | Provides a calibrated source of square-wave current. The arrow shows direction of conventional current flow (i.e. positive to negative). |
| POWER SWITCH | Toggle switch for turning the instrument on and off. |
| INTENSITY | Controls brightness of the display. |
| FOCUS | Used in conjunction with the INTENSITY and ASTIGMATISM controls for obtaining a well-defined display. |

| | |
|---|---|
| ASTIGMATISM | Used in conjunction with the INTENSITY and FOCUS controls for obtaining a well-defined display. |
| TRACE ROTATION | Permits horizontal alignment of the trace with respect to the horizontal lines of the graticule. |
| SCALE ILLUM | Varies illumination of the grid lines on the internal graticule. |
| Beam Position Indicators | Four neon lamps with accompanying arrows indicate the direction when the display is deflected out of the viewing area. |
| TRIGGER INPUT (Time Base A) | Connector for applying an external trigger signal to Time Base A when its SOURCE switch is set to EXT. |
| TRIGGER INPUT (Main Time Base (B)) | Connector for applying an external trigger signal to the Main Time Base (B) when its SOURCE switch is set to EXT. |

CAUTION

A MAXIMUM INPUT OF ± 30 VOLTS MUST NOT BE EXCEEDED IN THE EXTERNAL TRIGGER POSITION.

| | |
|---|---|
| HORIZ INPUT | Jack for applying external horizontal signal when the HORIZONTAL DISPLAY switch is set to either X1 or X10 EXT. |
| +GATE B | Supplies a 20-30-volt square-wave pulse when the Main Time Base (B) is operating. Pulse duration is approximately 10.5X the setting of the TIME/CM OR DELAY TIME switch when the VARIABLE control is set to CALIBRATED. |
| DLY'D TRIG | Supplies a sharp positive-going trigger spike of about 10 volts at the end of the delay period as set by the TIME/CM OR DELAY TIME switch and the DELAY-TIME MULTIPLIER control. |
| SWEEP A | Supplies the sawtooth voltage of TIME BASE A. Peak amplitude is about +100 volts. |
| +GATE A | Same as +GATE B except applies to Time Base A. |
| VERT SIG OUT | Vertical signal output connector. Output amplitude is approximately 0.4 volt per centimeter of deflection. |
| Chopped Blanking Switch (rear panel) | Provides blanking of between-channel switching transients when using multi-channel plug-in units in the chopped mode. |
| External Single Sweep Reset | Allows remote control of resetting in single-sweep operation. The sweep resets by the momentary application of +20 volts or more. |
| EXTERNAL DELAY INPUT (rear panel) | A four-pin connector is provided for an external delay generator (rather than the normal internal delay produced by the B sweep). Pin A of the connector permits disabling of the normal internal delayed trigger and is the feed-in point for the external delay trigger (see Fig. 2-1). Pin B is normally dc open and ac ground (through a 0.01 μf capacitor). Pin C supplies a B-gate pulse. Pulse characteristics are: +2 volts peak with a risetime of 50 nsec or faster into a load of 1 k paralleled by 100 pf. Duration of the pulse is the same as the length of the B sweep. Pin D is ground at all times. |

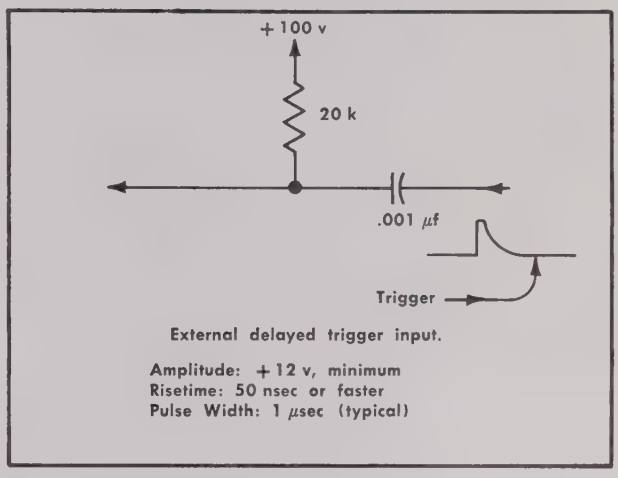


**Fig. 2-1. Method of coupling an external delayed trigger into the Type 546.**

## NORMAL (NON-DELAYED) SWEEP OPERATION

### Sweep Triggering

Proper sweep triggering is essential for a stable presentation of an input signal. For a stable display, the sweep must be triggered at the same time relative to the displayed signal. Thus, the sweep must be triggered by the displayed signal or by some external signal that has a fixed time relationship with the displayed signal. The external trigger signal must be the same frequency or a lower frequency multiple of the input signal.

### Selecting the Trigger Source

The SOURCE switches select one of a variety of possible triggering signals. For most applications, the sweep can be triggered internally from the displayed signal. This occurs with the SOURCE switch set at NORM.

The PLUG IN position is for plug-in units that will supply a single-channel triggering signal through pin 5 of the interconnecting plug such as the Tektronix Type 1A1 Dual-Trace Plug-In Unit. This position is useful when operating the plug-in unit in the dual-trace chopped-mode of operation since the triggering signal is the same as the applied signal and is free from any between-channel switching transients.

The LINE position of the SOURCE switch connects a line-frequency signal to the triggering network. Line triggering is useful whenever the input signal is related in frequency to the line frequency.

To trigger the time base from an external signal, set the SOURCE switch to EXT and connect the external trigger signal to the TRIGGER INPUT connector. External triggering is often used when signal tracing in amplifiers, phase-shift networks, and wave-shaping circuits. The signal from a single

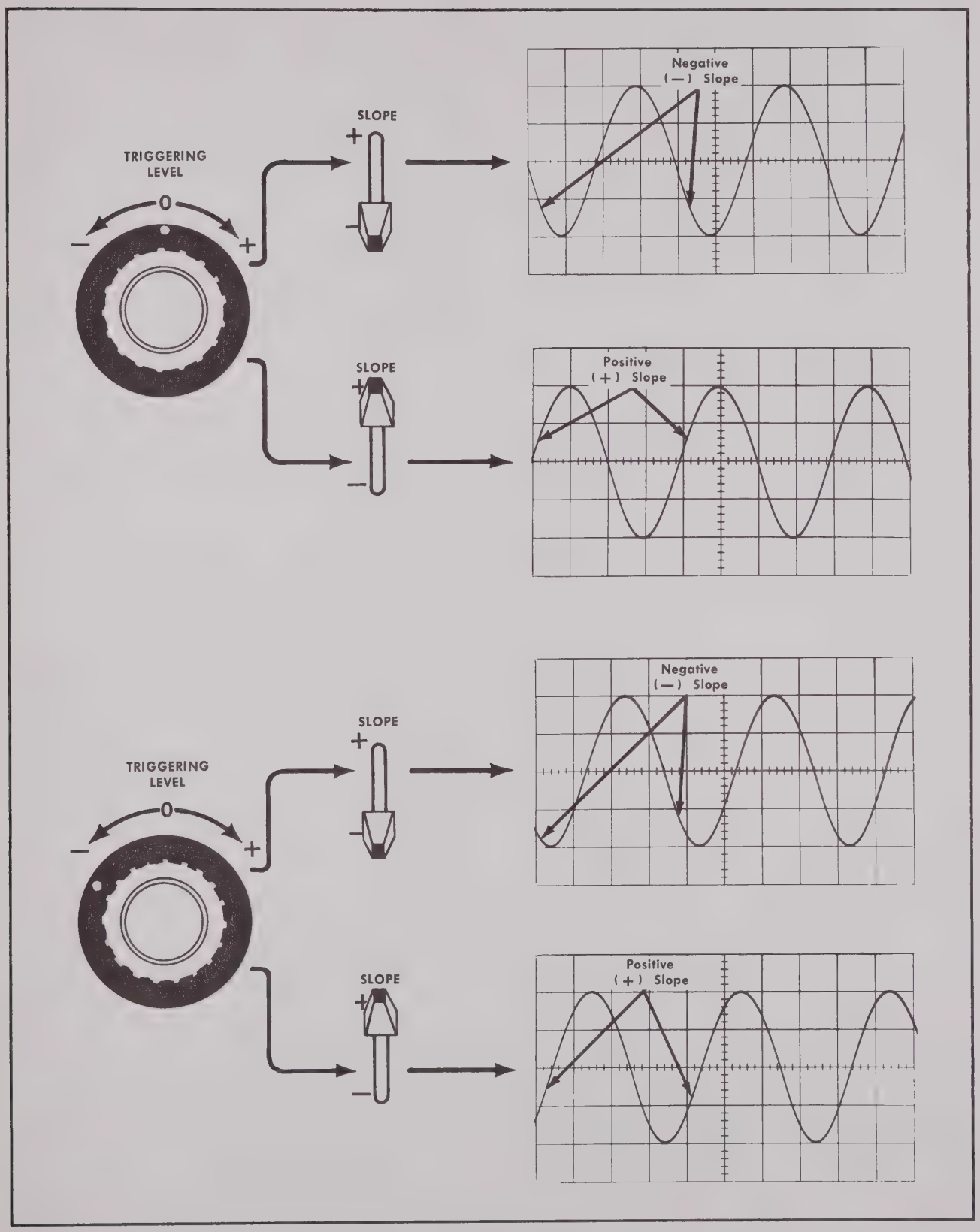


Fig. 2-2. Effects of the TRIGGERING LEVEL and SLOPE controls.



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point in the circuit can be used as the external trigger signal. With this arrangement, it is possible to observe the shaping and/or amplification of a signal at various points through the circuit without resetting the triggering controls for each new display.

## Selecting the Trigger Coupling

Three means of trigger coupling are available with the COUPLING switches. The different coupling positions permit you to accept or reject certain frequency components of the triggering signal.

With the COUPLING switch set at DC, the time base can be triggered with all frequency components of the triggering signal including dc levels.

With the COUPLING switch set at AC, the dc component of the triggering signal is blocked. Also, low-frequency signals below about 30 cps are attenuated.

With the COUPLING switch set at AC LF REJ, dc and low-frequency signals (below about 1.5 kc) are rejected or attenuated. Using AC LF REJ, the trigger circuit responds best to the higher frequency components of the triggering signal.

In general, use AC coupling. However, it will be necessary to use DC coupling for very low-frequency signals. When line frequency hum is mixed with the triggering signal, it is best to use AC LF REJ coupling so that triggering takes place only on the signal of interest (if the signal of interest contains frequency components above about 1.5 kc).

The AC LF REJ coupling position is also useful when triggering internally from multi-trace plug-in units operated in the alternate mode of dual trace (unless the plug-in unit is a Type 1A1 and the SOURCE switch is set to PLUG IN). AC LF REJ coupling has a faster recovery time when subjected to the alternate dc levels from the multi-trace plug-in unit.

## Selecting the Trigger Slope

The trigger SLOPE switch determines whether triggering occurs on the rising (+ setting) or the falling (— setting) portion of the triggering signal. When several cycles of a signal appear in the display, the setting of the SLOPE switch will probably be unimportant. However, if you wish to look at only a certain portion of a cycle, the SLOPE switch will help you to start the display on the desired slope of the input signal. Fig. 2-2 illustrates the effect of both the SLOPE and TRIGGERING LEVEL controls.

## Selecting the Trigger Mode

The AUTO STABILITY mode is generally more convenient. With the MODE switch set to AUTO STABILITY, proper triggering takes place after setting the TRIGGERING LEVEL control. When the triggering signal is removed, the time base circuit automatically free runs and presents a reference display.

The TRIG position of the MODE switch should be used if the repetition rate of the trigger signal has a very low repetition rate (below about 20 cps).

## Setting the Triggering Level

The TRIGGERING LEVEL control determines the amplitude point on the signal where triggering occurs.

The trigger circuit is most sensitive to ac triggering signals with the TRIGGERING LEVEL control set near zero and pushed in. Moving the TRIGGERING LEVEL control in the + direction causes the trigger circuit to respond at some higher positive amplitude on the triggering signal. Moving the TRIGGERING LEVEL control in the — direction causes the trigger circuit to respond at some higher negative amplitude on the triggering signal. Fig. 2-2 illustrates the effect of the TRIGGERING LEVEL control and the SLOPE switch.

The range of the TRIGGERING LEVEL control is extended 10 times when it is pulled out. This permits more satisfactory triggering on larger amplitude trigger signals.

## Selecting the Time/Cm (Sweep Rate)

The TIME/CM and SWEEP MAGNIFIER switches control sweep rate of the display. The SWEEP MAGNIFIER expands the displays of both time bases.

The TIME/CM and SWEEP MAGNIFIER allow you to view an applied signal at a wide variety of calibrated sweep rates. When you make time measurements from the crt, be sure the VARIABLE control is set to CALIBRATED.

When the SWEEP MAGNIFIER is set to X1, the TIME/CM switch indicates the displayed sweep rate. With SWEEP MAGNIFIER set to X2 (for example), divide the setting of the TIME/CM switch by 2 to determine the true sweep rate. For example, assume that the TIME/CM switch is set at 1 mSEC per division and the SWEEP MAGNIFIER is set to X5. In this case, the true sweep rate would be 1 (msec) divided by 5 (SWEEP MAGNIFIER setting); giving a displayed sweep rate of .2 milliseconds per division. Fig. 2-3 illustrates how to make time measurements from the graticule.

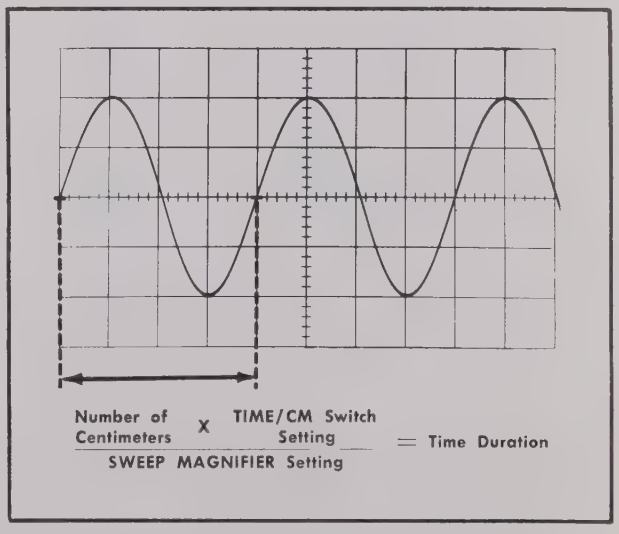



Fig. 2-3. Illustration of time measurement from the graticule.

## Single Sweep Operation

In applications where the displayed signal is not repetitive or varies in amplitude, shape, or time, a conventional repetitive display may produce a jumbled display. To avoid this, use the single sweep feature of the Type 546 oscilloscope.

To use single sweep, first make sure the trigger circuit will trigger on the event you will wish to display. Do this in the conventional manner with the SINGLE SWEEP switch set at NORMAL.

Depress the SINGLE SWEEP to the RESET position and release the switch so it returns to the SINGLE SWEEP position. When this is completed, the next trigger pulse will actuate the sweep and the instrument will display the event on a single trace. The READY lamps, near the HORIZONTAL DISPLAY switch, first light when the sweep is ready to accept a trigger and then go out after triggering has taken place. To ready the circuit for another single display, depress the SINGLE SWEEP switch to RESET and release. In single sweep operation, make sure the MODE switch is set to TRIG.

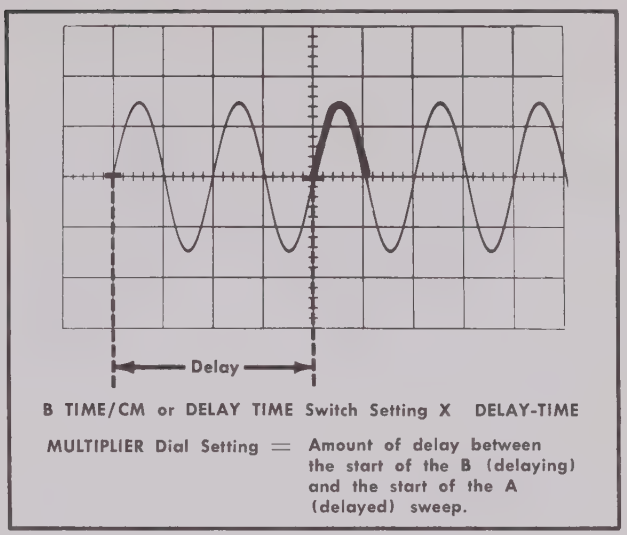

Delay
B TIME/CM or DELAY TIME Switch Setting X DELAY-TIME MULTIPLIER Dial Setting = Amount of delay between the start of the B (delaying) and the start of the A (delayed) sweep.

Fig. 2-4. Determining delay time.

## NON-TRIGGERED DELAYED SWEEP

### Introduction

The following describes various measurements and other operations that can be performed using delayed sweep; the accuracy of those measurements; and the operating procedures involved.

Insert a vertical plug-in unit and set the controls and switches on the instruments as listed in Table 2-1.

Set HORIZONTAL POSITION so the trace begins precisely at the left-hand edge of the graticule. Notice the position of the intensified segment in the trace.

Now set the B TIME/CM OR DELAY TIME switch to .2 SEC and A TIME/CM to 20 mSEC. The intensified segment should be at the same position as with the previous sweep rates.

Connect the SWEEP A output to the vertical plug-in unit input. Notice that the A sweep sawtooth and the intensified segment in the trace start and end at the same time. This display shows that TIME BASE A produces one sweep during the intensified segment of each B sweep. The A TRIGGERING LEVEL control has no effect.

The B sweep rate is .2 second per centimeter. The intensified segment begins 5 centimeters after the beginning of the trace. Hence, the A sweep starts one second after the B sweep (0.2 second per centimeter times 5 centimeters).

The number of centimeters between the beginning of the trace and the beginning of the intensified segment is established by the setting of the DELAY-TIME MULTIPLIER control. Therefore, with any dial setting, the time difference between the beginning of the A and B sweeps is the product of the B TIME/CM OR DELAY TIME and the DELAY-TIME MULTIPLIER dial setting (see Fig. 2-4).

TABLE 2-1

| | |
|---|---|
| B MODE | AUTO STABILITY |
| B SOURCE | NORM |
| B COUPLING | AC |
| B SLOPE | + |
| B TRIGGERING LEVEL | 0 |
| B TIME/CM OR DELAY TIME | 1 mSEC |
| A MODE | AUTO STABILITY |
| A SOURCE | EXT |
| A TIME/CM | .1 mSEC |
| VARIABLE (A and B) | CALIBRATED |
| HORIZONTAL DISPLAY | B INTENS BY 'A' |
| SWEEP MAGNIFIER | OFF (X1) |
| DELAY-TIME MULTIPLIER | 5.00 |
| AMPLITUDE CALIBRATOR | 10 Volts |
| HORIZONTAL POSITION | Centered |
| INTENSITY | So both intensity levels in the trace are easily seen. |

Set the applicable controls and switches of the vertical plug-in unit as follows:

| | |
|---|---|
| VOLTS/DIV | 5 |
| VARIABLE | CALIBRATED |
| AC-DC-GND | DC |
| POSITION | Trace Centered |

The following procedures show five common applications of the delayed sweep feature. These applications are more accurate than the time measurements that are taken directly from the crt display.

### Demonstration 1

Measurement of pulse duration with the pulse triggering the Main Time Base (B).

Set the controls and switches on the instrument as listed in Table 2-1 except as follows:

| | |
|---|---|
| B TIME/CM OR DELAY TIME | .1 mSEC |
| A TIME/CM | 1 μSEC |

Apply the AMPLITUDE CALIBRATOR signal to the input of the vertical plug-in unit. If necessary, adjust B TRIGGERING LEVEL to obtain a stable display. The display should consist of nearly one cycle of the square-wave signal.

Set the DELAY-TIME MULTIPLIER dial to intensify the falling portion of the square wave. Set the HORIZONTAL DISPLAY switch to A DLY'D. The display should now be a horizontally expanded version of the signal observed in the intensified segment of the previous display. Adjust the BRIGHTNESS control of the Main Time Base (B) to equalize the intensity.

Set DELAY-TIME MULTIPLIER so the falling 50% point on the delayed trace exactly crosses the point where the 50% amplitude level on the rising portion of the intensified display appeared (this point may be hard to see but will be very near the start of the trace). Multiply the DELAY-TIME MULTIPLIER dial reading (e.g. 5.03) by the B TIME/CM OR DELAY TIME setting. The product is the time duration of the square wave positive-going half-cycle.

Accuracy: Accuracy is determined by the combination of all the following factors:

1. The basic accuracy of time measurements made by using sweep delay is as stated in Section 1 of this manual.

2. The DELAY PICKOFF and Time Base A generator circuits typically require a net total of about 75 to 100 nanoseconds to respond to the signal event which triggers the Delayed Sweep (A). This small inherent delay need not be considered unless it is a significant percentage (delay times shorter than 50 μsec) of the measured time or when measuring time differences when using the same sweep delay range. When necessary, add the net circuit delay time to the measured time: that is, when measuring the time from the start of the B sweep.

Summary: The method described in Demonstration 1 provides a time measurement accuracy within 1% of reading ±2 minor division of the DELAY-TIME MULTIPLIER dial.

By comparing the delay reading to an accurate external timing standard (such as a Tektronix 180A Time Mark Generator) and applying a correction factor, an accuracy of ±2 minor divisions of the DELAY-TIME MULTIPLIER dial can be achieved.

## Demonstration 2

Measuring time between two pulses, neither of which triggers Time Base A.

Set the controls and switches on the instrument as listed in Table 2-1 except as follows:

| | |
|---|---|
| B TIME/CM OR DELAY TIME | .2 mSEC |
| A TIME/CM | 2 μSEC |

Apply the AMPLITUDE CALIBRATOR signal to the vertical input. If necessary, adjust the 'B' TRIGGERING LEVEL to obtain a stable display. The display should consist of about two cycles of the square wave. Set the DELAY-TIME MULTIPLIER so the square wave rise located near the center of the display is intensified.

Set the HORIZONTAL DISPLAY to the A DLY'D position. The display should now be a horizontally expanded version of the intensified segment.

Set DELAY-TIME MULTIPLIER so the rising 50% amplitude level of the square wave intersects the vertical centerline of the graticule. Note the exact setting of the DELAY-TIME MULTIPLIER (e.g. 5.48). Turn the DELAY-TIME MULTIPLIER clockwise until the falling 50% amplitude level of the square wave intersects the same vertical graticule centerline used with the previous dial setting. Again note the exact setting of DELAY-TIME MULTIPLIER dial.

Subtract the first dial setting from the second. The product of the difference times the B TIME/CM OR DELAY TIME equals the time duration of the square-wave positive-going half-cycle (between the 50% amplitude points). This measurement should indicate a time of about 0.5 millisecond.

Accuracy: Accuracy is determined by the combination of the following factors:

1. The basic accuracy of the sweep delay, as described in Demonstration 1.

2. The error added by the sweep-delay system linearity is ±2 minor dial divisions of the DELAY-TIME MULTIPLIER dial. Hence, per cent error of measurement decreases as the numerical dial difference increases.

NOTE

**When the separation between dial settings is 100 minor dial divisions or less, the time measurement can often be made more accurate by direct reading from a magnified crt display. See Demonstration 3; Magnification.**

3. The accuracy of time measurements made in Demonstration 2 is independent of the inherent circuit delays providing the B TRIGGERING LEVEL control setting is the same for each of the two dial readings.

Summary: The method described in Demonstration 2, provides time measurement accuracy as stated in Section 1. Accuracy will be greatest when the numerical dial difference between the two DELAY-TIME MULTIPLIER readings is greatest.

## Demonstration 3

Complex signals contain a number of individual events of different amplitudes. Since the trigger circuits of the Type 546 respond to signal amplitude, a stable display will normally be obtained only when the sweep is triggered by the event having the greatest amplitude. The A DLY'D mode permits the start of the A sweep to be delayed for a selected time after the signal event having the greatest amplitude. Any event within the series of events may then be displayed in magnified form as follows:

Set the controls and switches on the instrument as listed in Table 2-1. Apply the AMPLITUDE CALIBRATOR signal to the vertical input. If necessary, adjust B TRIGGERING LEVEL to obtain a stable display. The display should consist of several cycles of the square wave signal. Set DELAY-TIME MULTIPLIER to intensify one of the positive-going pulses.

Set the HORIZONTAL DISPLAY switch to A DLY'D. The display should now be the same signal information as the intensified trace segment, but horizontally expanded (magnified) ten times.

Increase the A sweep rate to 1 microsecond per division. Set DELAY-TIME MULTIPLIER to position a square wave rise on the crt. The display now gives X1000 magnification of the intensified segment.

Slowly turn the DELAY-TIME MULTIPLIER dial. Note that any portion of the square wave can be brought into view in magnified form.

The DELAY-TIME MULTIPLIER reading corresponds to the number of centimeters between the beginning of the time base B trace and the beginning of the time base A (intensified) trace: e.g. 7.00=7 major divisions.

The A DLY'D display will probably exhibit some horizontal jitter. The time jitter contributed by the delay system is less than $5 \times 10^{-5}$ times the B TIME/CM OR DELAY TIME setting. Since the sweep rate of the delayed sweep is now 1 microsecond per centimeter, the jitter due to the delay system is less than one-half centimeter.

Accuracy: The accuracy of time measurements made from magnified displays depends solely on the B sweep rate accuracy as listed in Section 1 of this manual.

## Demonstration 4

### Delayed Trigger

Ordinarily the displayed signal is also used to trigger the oscilloscope sweep. In some situations, it may be desirable to reverse this situation. The sweep-related output pulses, available from the front panel of the Type 546, can be used as a triggering signal for an external device. The output signal of the external device can then produce a stable display while the oscilloscope sweep free-runs.

To demonstrate one method of performing this operation, proceed as follows:

Set the controls and switches on the instrument as listed in Table 2-1 except as follows:

| | |
|---|---|
| B SOURCE | EXT |
| DELAY-TIME MULTIPLIER | 1.00 |
| B TIME/CM OR DELAY TIME | 10 μSEC |
| A TIME/CM | 1 μSEC |

Connect DLY'D TRIG to the vertical input. The display should consist of a positive-going spike.

The oscilloscope display shows the pulse that is available at the Type 546 at the end of each delay period. In a practical application, the pulse would not be applied to the vertical input, but to some external device to be tested. The pulse would serve as the trigger pulse, or input signal for the external device and the output of the device will provide a stable display on the oscilloscope, as though the oscilloscope were triggered in the normal manner.

## Demonstration 5

### Pulse Generation

The +GATE A output signal of the Type 546 can be used as a variable repetition rate, variable duty factor pulse generator. To use the Type 546 in this manner, proceed as follows:

Set the controls and switches of the instrument as listed in Table 2-1 except as follows:

| | |
|---|---|
| DELAY-TIME MULTIPLIER | About 0.20 |

Monitor the signal available at the +GATE B connector on another oscilloscope and establish the desired pulse repetition rate by setting the B TIME/CM OR DELAY TIME switch and VARIABLE B. Establish the desired duty factor by setting A TIME/CM.

The maximum pulse repetition frequency that can be obtained in this manner is about 130 kc. Maximum duty factor is about 0.9, decreasing to about 0.15 with faster sweep rates.

## TRIGGERED DELAYED SWEEP

Complex signals contain a number of individual events at different amplitudes. Since the trigger circuits in the Type 546 respond to signal amplitude, a stable display will normally be obtained only when the sweep is triggered by the event having the greatest amplitude.

The following instructions demonstrate that Time Base A can be triggered by virtually any event within a series of events, regardless of relative amplitude.

Set the controls and switches on the instrument as listed in Table 2-1.

Connect the AMPLITUDE CALIBRATOR signal to the vertical input. You should obtain a square-wave display.

Turn DELAY-TIME MULTIPLIER about 2 turns in either direction. Notice that the brightened segment in the display moves smoothly across the crt.

Set the DELAY-TIME MULTIPLIER so the brightened segment begins about in the middle of a pulse top. Now, set the A MODE to TRIG and the A SOURCE to NORM. Notice that the brightened segment in the display has shifted to the next pulse on the right. (If the brightened segment does not appear, or is unstable, readjust A TRIGGERING LEVEL). Turn the DELAY-TIME MULTIPLIER dial several full turns. The brightened segment in the display should jump from one pulse to the next. Set HORIZONTAL DISPLAY to A DLY'D and notice that the display now begins on the rising portion of the pulse. With the present display, if you turn the DELAY-TIME MULTIPLIER dial you will see no change in the display since all of the AMPLITUDE CALIBRATOR pulses are the same shape. However, if the input signal consisted of a repeating series of several dissimilar pulses, turning the dial would provide a triggered display of each pulse in the series (providing A TRIGGERING LEVEL is set for triggering on the smallest pulse).

The display is produced in the following manner:

Time Base A produces one sweep during each B sweep. The Time Base A sweep will begin at some time after the start of B sweep. This time is the total of (1) the B TIME/CM OR DELAY TIME setting multiplied by the DELAY-TIME MULTIPLIER setting, plus (2) the time between the end of this delay interval and the next event in the signal which can trigger Time Base B.

The Time Base A sweep will occur only if A is triggered before the B sweep ends. If B sweep ends while the A sweep is in progress, A sweep will also terminate. If this occurs, the A DLY'D display will not be the full width of the graticule.

## EXTERNAL HORIZONTAL DEFLECTION

For special applications, you can produce horizontal deflection with an externally derived signal. This permits use of the oscilloscope system to plot one function against another (e.g. Lissajous figures). However, the system is not intended for precision phase-angle measurements.

To use an external signal for horizontal deflection, connect the signal to the HORIZ INPUT connector. Set HORIZONTAL DISPLAY to EXT. The signal is dc coupled to the deflection amplifier. The MAG switch is inoperative when the HORIZONTAL DISPLAY switch is set to either external horizontal position.

## Transformer and Fan Connections

See Figs. 2-5 and 2-6 for transformer and fan connections necessary to operate the Type 546 at line voltages from 108 to 244 volts, 50 to 60 cps and 400 cps.

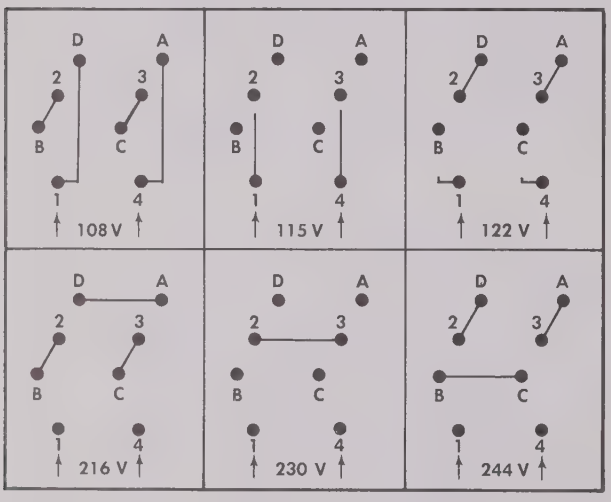



Fig. 2-5. Transformer connections for 108 to 244 volt, 50 to 60 cps and 400 cps operation.

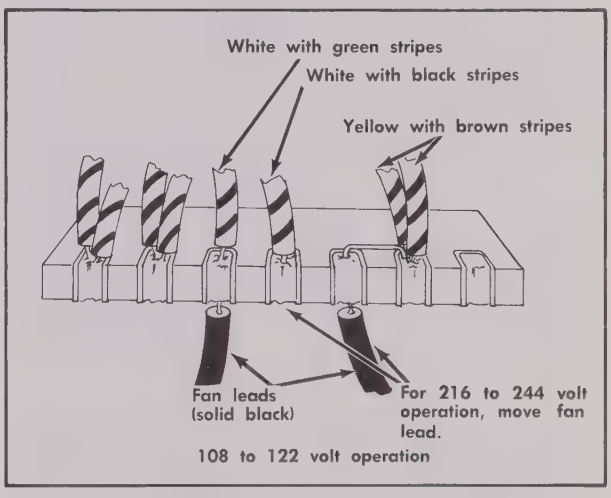

White with green stripes
White with black stripes
Yellow with brown stripes
Fan leads (solid black)
For 216 to 244 volt operation, move fan lead.
108 to 122 volt operation

Fig. 2-6. Fan connections for 108 to 244 volt, 50 to 60 cps and 400 cps operation.

# SECTION 3

# CIRCUIT DESCRIPTION

## Introduction

This section contains the theory of operation of the various circuits in the Type 546. A simplified block diagram analysis is given first to explain the operation of each circuit in general terms, then the operaton of each circuit is covered in detail.

## BLOCK DIAGRAM ANALYSIS

In the following analysis, it is assumed that the oscilloscope is equipped with a dual-channel vertical plug-in preamplifier, and that the horizontal display switch is set in the A DLY'D BY B position. Fig. 3-1 is a simplified block diagram showing the Type 546 operating in this mode. The functions of the various blocks in Fig. 3-1 are explained in the following paragraphs.

**Low-Voltage Power Supply.** The low-voltage power supply produces all operating voltages for the oscilloscope with the exception of parts of the crt circuit. The low-voltage supply provides regulated —150, +100, +225, and +350 volts. It also provides heater voltages and an unregulated +325-volt output.

**Vertical Plug-In Preamplifier.** Any Tektronix letter-series or 1-series vertical plug-in preamplifier can be used with the Type 546. For a circuit description of the plug-in unit, refer to the plug-in unit instruction manual.

**Vertical Input Amplifier.** The vertical input amplifier is a balanced, hybrid amplifier that amplifies the output of the plug-in vertical preamplifier and applies the amplified vertical signal to the trigger-pickoff circuit and the vertcal output amplifier.

**Delay Line.** The push-pull output of the vertical input amplifier is applied through the balanced delay line to the vertical output amplifier. The delay line is a specially braided 186-ohm line which delays the application of the vertical signal to the vertical output amplifier for 170 nsec. This provides time for unblanking the crt and starting the horizontal sweep before the vertical signal reaches the deflection plates. The delay allows the leading edge of a single fast-rising pulse to be displayed. The delay line requires no adjustment because of the precision construction.

**Vertical Output Amplifier.** The vertical output amplifier is a push-pull, three-stage, transistor amplifier that takes the output of the delay line and amplifies it to a level sufficient to drive the vertical deflection plates of the crt.

**Trigger-Pickoff Circuit.** The trigger-pickoff circuit applies a sample of the input waveform to the trigger circuits of both time bases. The trigger is picked off at the output of the vertical input amplifier.

**Main Time Base (B) Generator.** The Main Time Base (B) generator provides accurate ramp voltages for the horizontal deflection system, unblanking for the crt, and a +B gate to a front-panel connector. The Main Time Base (B) generator may be triggered by signals derived from either internal or external sources.

**Delay-Pickoff Circuit.** The delay-pickoff circuit compares the ramp-voltage output of the Main Time Base (B) generator with a variable reference voltage, and assuming identical characteristics in the two halves of the compartor, generates a trigger pulse when the two voltages are equal. The trigger output of the delay-pickoff circuit may be used to arm or trigger Time Base A, and is also available at a front-panel connector.

**Horizontal Amplifier.** The input to the horizontal amplifier is selected from the outputs of the Main Time Base (B) generator, Time Base A generator, or the external horizontal input amplifier. The selected input is split in-phase and amplified to provide push-pull drive to the horizontal deflection plates of the crt.

**External Horizontal Amplifier.** The external horizontal input amplifier provides the necessary gain to drive the horizontal amplifier from external signals. An input attenuator and a gain control provide horizontal deflection factors from 0.1 to about 10 volts/cm.

**Crt Power Supply.** The crt power supply provides the high voltages for operating the crt. The power supply is of the rf type, using a 50-kc Hartley oscillator. Secondary windings on the oscillator transformer supply voltages to the high-voltage rectifiers.

**Cathode Ray Tube (Crt).** The cathode-ray tube used in the Type 546 is a flat-faced, internal graticule, 5-inch tube with 6 cm of useable vertical scan area. The tube is designed for low input capacitance to the vertical deflection plates and minimum x-axis center-to-edge defocusing.

**Calibrator.** The calibrator in the Type 546 is a multivibrator and cathode follower that provides a square-wave output with a maximum amplitude of 100 volts at a nominal 1 kc. A step attenuator permits switching the output amplitude from the front panel. In the 0.2-mvolt to 200-mvolt range, the output impedance is 50 Ω.

**Time Base A Generator.** The Time Base A generator closely resembles the Main Time Base (B) generator. The description of functions and the circuit analysis given for the Time Base (B) generator in most instances apply also to the Time Base A generator.

## CIRCUIT ANALYSIS

The following circuit analysis of the Type 546 describes the operation of the various circuits in detail. While reading through the description of a particular circuit, refer to the circuit diagram being discussed (see Section 6).

### Low-Voltage Power Supply

The low-voltage power supply in the Type 546 (see Power Supply schematic) actually consists of four interrelated supplies that operate together as a system. This system delivers filtered and regulated voltages of —150, +100, +225, and +350 volts as well as an unregulated dc voltage of +325 volts. A common power transformer, T601, supplies the input power to each of the supplies, as well as heater power to time-delay relay K600 and the tubes in

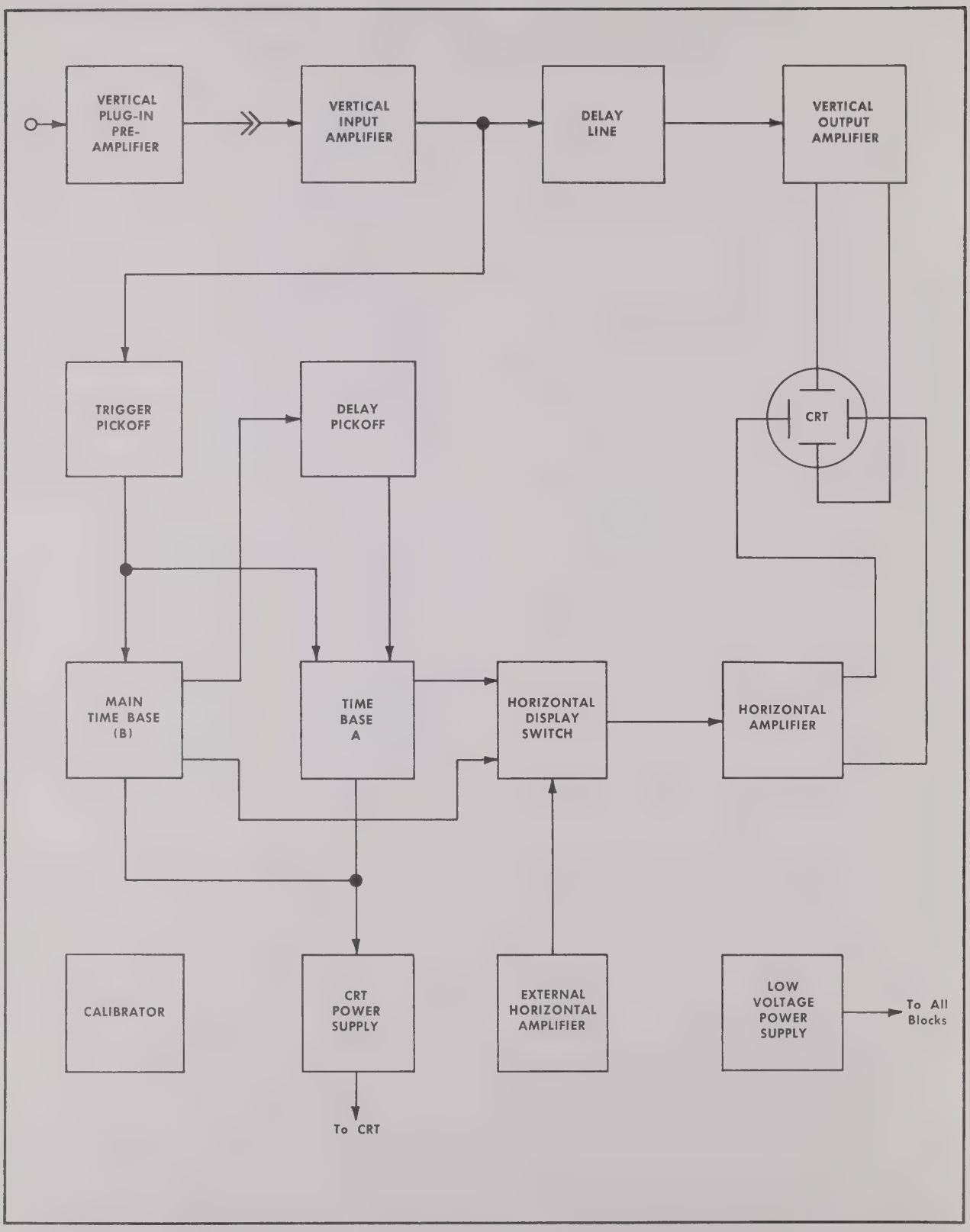



Fig. 3-1. Type RM546 simplified block diagram.

the oscilloscope. Unless otherwise specified, the Type 546 is shipped with T601 wired for 115-volt ac input. A connection diagram on the side of the transformer shows alternate connections for other input voltages.

The 115-volt ac input power is applied to T601 through POWER ON switch SW601. Overload protection is provided by fuse F601. Thermal cutout TK601 in the primary circuit of T601 is a protective device that opens the transformer primary circuit if the temperature inside the oscilloscope rises above a safe value. TK601 resets automatically when temperatures return to normal; and to shorten the cooling time, the fan continues to run while TK601 is open (except when T601 is connected for 216-244-volt operation). Thermal time-delay relay K600 provides a filament warmup time of approximately 30 seconds before the dc power supplies are activated. The heater of K600 is rated at 6 volts and is connected to 6.3 volts on the T601 secondary winding. During heater warmup time, contacts 4 and 9 of relay K600 remain open. At the end of heater warmup time, contacts 4 and 9 close and apply power to magnetic relay K601. Contacts K601-1 of relay K601 remove the heater power from K600, but before K600 can open, contacts K601-1 lock the holding circuit to the coil of K601. K601 now remains energized until the power to the oscilloscope is switched off or otherwise interrupted. When K601 is energized, contacts K601-2, K601-3, K601-4, K601-5 and K601-6 are also closed and thus activate their respective dc supplies.

**—150-Volt Supply.** The —150-volt supply in the Type 546 is the reference voltage source for the other supplies and must be very stable. The —150-volt supply includes a high-gain electronic voltage regulator designed to give good regulation under extreme operating conditions. This regulator circuit contains a series regulator, a glow-discharge tube reference source, an error detector, and an amplifier.

In operation, the input power to the —150-volt supply is supplied by one secondary winding of T601. The ac output of the secondary winding is rectified by silicon-diode rectifier bridge D642 and filtered by capacitor C642A. In series with the positive side of the supply and ground are series regulator tubes V637 and V647, paralleled by shunting resistors R646 and R647. The output of the —150-volt supply is taken from the negative side.

Error sensing in the voltage-regulator circuit is accomplished by comparator tube V624. Current flow through V624 is established by the setting of the tap on R616 in the voltage divider R615, R616, and R617. The voltage on the grid of V624A is held at approximately —85 volts by reference tube V609. Assuming that the output voltage of the —150-volt supply increases due to increased line voltage or some other cause, the voltage increase appears on the cathodes of V624 and, through the tap on R616, on the grid of V624B. Due to the voltage divider, only a part of the voltage increase appears between the grid and cathode of V624B, but the full change appears on the grid and cathode of V624A. The increase is in the negative direction, therefore, V624A increases its conduction to maintain the proper bias between grid and cathode, and this holds both cathodes more or less fixed while the grid of V624B is pulled negative by the increasing negative voltage across the voltage divider. The increasing negative voltage on the grid of V624B causes a decrease in current; thus, the plate voltage goes positive.

The positive change in plate voltage is amplified and inverted to a negative change by amplifier tube V634. The amplified error signal from V634 is applied to the grids of series regulator tubes V637 and V647. The negative-going error signal on the grids of V637 and V647 decreases the current through the tubes, effectively increasing their resistance and the voltage drop across them. The voltage necessary to provide the increased drop across the series regulator tubes and shunt resistors can only be obtained by subtracting it from the negative side of the supply, so the undesired increase in negative voltage is absorbed in the series regulators and shunt resistors. If the output of the —150-volt supply had decreased instead of increased, then the error voltage applied to the grids of the series regulators would have been positive-going. The positive-going error voltage on the grids of the series regulators would lower the resistance of the series regulator tubes, and the voltage drop across them would decrease, leaving more voltage for the negative side of the supply. Since the output voltage of the —150-volt supply depends upon the relationship of the voltage on the tap of R616 and the reference voltage from V609, accurate adjustment of the output voltage is provided by making R616 variable.

Filter capacitor C642A does not remove all the ripple from the output of the bridge rectifier, thus the series regulator circuit also helps to reduce this output ripple voltage. Any ripple between the —150-volt output point and ground reaches the grid (pin 2) of V624A via capacitor C610. This input ripple voltage is amplified by V624 acting as a cathode-coupled amplifier. The ripple output voltage at the plate (pin 6) of V624B has the same polarity as the ripple voltage at the —150-volt output. C628 couples this ripple output voltage to the grid of V634. The ripple voltage is further amplified by V634 and applied to the grids of the series regulator tubes with a polarity that opposes the original ripple voltage. Ripple in the positive side of the —150-volt supply is coupled into a degenerative feedback loop through R637 to the screen of V634.

Some of the components in the —150-volt supply are not necessary in normal operation but are included to insure proper operation of the circuit under adverse conditions. C636 provides for proper operation of the circuit when extremely low temperatures reduce the capacitance of the electrolytic filter capacitors. R640 and R641 protect against large surge currents, and C642B suppresses sudden load changes that fall outside the bandwidth of the regulator circuit.

**+100-Volt Supply.** The input to the +100-volt supply is the output of secondary winding 19-20 of transformer T601 and silicon diode bridge D672. In addition to its other loads, the +100-volt supply is required to supply current to a series string of filaments at all times. When the Type 546 is first turned on, relay K601 contacts are open and all the regulated supplies are inoperative. During this time, the series-string filaments are supplied by the unregulated side of the +100-volt supply through relay contact K601-4. By the time relay K600 activates K601, the series-string filaments have reached operating temperature. When K601 is activated by K600, relay contacts K601-4 shift the series string filaments to the regulated output of the +100-volt supply.

The reference voltage source is the regulated output of the —150-volt supply. V664A is the error amplifier, V664B compensates for V664A grid-cathode contact bias changes caused by changing line voltage, and V667 is the series regulator tube. The error-feedback circuit is through R650 and R651, the junction of which is connected to the grid of V664A. The top end of R650 is connected to the regulated +100-volt output, and the lower end of R651 is connected to the output of the regulated —150-volt supply to obtain reference voltage. With normal line voltages and loads, the voltage at the junction of R650 and R651 is about —1.7 volts with reference to ground; this is the operating bias of V664A.

If the load current, output voltage, or the input voltage changes (including changes due to ripple), the output of the regulated +100-volt supply starts to change also, but any change appears across R650 and R651 and is applied to the grid of V664A as a change in operating bias. Assuming that the output of the regulated +100-volt supply tries to decrease, the reduced voltage at the top end of R650 permits the voltage at the junction of R650 and R651 to go more negative than the normal —1.7 volt level at that point. The increase in negative bias on the grid of V664 reduces the flow of plate current through V664A, the voltage drop across plate load resistor R663 decreases, and the plate voltage of V664 and the grid bias of V677 go more positive. As the grid of V677 goes more positive, the resistance that V677 offers to the flow of current is decreased and the output voltage rises, compensating for the drop in output voltage which initiated regulating action. Of course, the regulator circuit can never completely compensate for a change in output voltage, for there must be an error input for the circuit to operate, but any error in output is reduced by a factor equal to the loop gain of the regulator circuit.

The screen grid of V664 is used as a signal grid for injecting a sample of any ripple or transient voltages present in the unregulated side of the +100-volt supply into the regulator circuit. The regulator circuit thereby becomes a dynamic filter for ripple reduction. The ripple signal is applied to the screen of V664A, amplified and inverted in phase by V664A, then applied to the grid of V667. By the time the amplified and inverted ripple gets to the grid of V667, it is of proper amplitude and phase to cancel out the ripple appearing at the plate of V677.

To keep the proper load on the +100-volt supply when the vertical plug-in preamplifier is removed, a plug-in sensing switch is built into the main frame of the Type 546 at the top rear of the plug-in compartment. When the plug-in unit is removed, the sensing switch connects a resistive load in place of the series-filament string. When it is desired to operate the plug-in unit outside the Type 546 by means of a test harness, the sensing switch must be manually operated. To manually operate the switch, pull the plastic plunger outward to the stop position.

**Unregulated +325-Volt Supply.** The unregulated +325-volt supply voltage source differs somewhat from the voltage sources for the —150- and +100-volt supplies. A center-tapped secondary (13-14-15) on T601 and silicon diodes D702 and D732 form a center-tapped bridge rectifier circuit with the negative side connected to the positive unregulated side of the voltage source for the +100-volt supply. The unregulated +325-volt output is taken from the transformer center-tap (14) connection.

The unregulated output of the voltage source for the +100-volt supply is approximately +180 volts. The unregulated output of the center-tapped bridge circuit is approximately +290 volts; this, added to the unregulated +180 volts provides the +470 volts. However, for the unregulated +325-volt output, the connection is made at the center tap (+145 volts) of the bridge (the midpoint of the +290 volts). Adding the +180 and +145 volts provides the desired output of +325 volts.

**+225-Volt Supply.** The voltage source for the regulated +225-volt supply is the unregulated +325-volt supply described in the preceding paragraphs. The regulator circuit is similar to the regulator circuit found in the —150-volt supply; the main difference being that instead of using a glow discharge tube as a reference voltage source, the reference voltage is from the —150-volt supply. The error signal is picked off the junction of precision resistors R680 and R681. The upper end of R680 is connected to the +225-volt output, and the lower end of R681 is connected to the regulated —150-volt supply. The voltage at the junction between R680 and R681 is approximately —0.9 volt which is applied through R682 and R683 to the grid of V684B. The cathodes of V684 are long-tailed to the —150-volt supply through resistor R685. The grid of V684A is grounded. The error signal is fed from the grid of V684B through the common-cathode circuit to the A side of the tube. Notice that this comparator is somewhat different from the comparator used in the —150-volt supply; the output is taken from the A side. The error signal is amplified by V684 and fed, unchanged in phase, to the voltage divider in the grid of V694. V694 also amplifies and inverts the error signal and applies it, out of phase with any change in the +225-volt output, to the grid of series regulator tube V707.

Here again, the screen of the error amplifier tube is acting as an injection grid for ripple reduction. A sample of the unregulated supply ripple is applied to the screen of V694. V694 amplifies the ripple, inverts it in phase, and applies it to the grid of series regulator tube V708. The result is that the same ripple appears simultaneously on the grid and plate of V707, but 180° out of phase; thus the ripple cancels out.

**+350-Volt Supply.** The input to the +350-volt supply is the full voltage output of the center-tapped bridge (see description of +325-volt supply) added to the unregulated side of the +100-volt supply. The operation of the regulator circuit is very similar to the operation of the +100-volt regulator except for different component values and no grid cathode contact-bias compensating diode.

## Crt Circuit

The crt circuit (see Crt schematic) includes the crt, the high-voltage power supply, and the controls necessary to focus and orient the display. The crt (Tektronix Type T5470-31-2) is an aluminized, 5-inch, flat-faced, glass crt with a helical post-accelerator and electrostatic focus and deflection. The crt circuit provides connections for externally modulating the crt cathode. The high-voltage power supply is composed of a dc-to-50 kc power converter, a voltage-regulator circuit, and three high-voltage outputs. Front-panel controls in the crt circuit adjust the trace rotation (screwdriver adjustment), intensity, focus, and astigmatism. Internal controls adjust the geometry and high-voltage output level.

**High-Voltage Power Supply.** The high-voltage power supply is a dc-to-ac converter operating at approximately 50 kc with the transformer providing three high-voltage outputs. The use of a 50-kc input to the high-voltage transformer permits the size of the transformer and filter components to be kept small. A modified Hartley oscillator converts dc from the +325-volt unregulated supply to the 50-kc input required by high-voltage transformer T801. C808 and the primary of T801 form the oscillator resonant tank circuit. No provisions are made for precise tuning of the oscillator tank since the exact frequency of oscillation is not important.

**Voltage Regulation.** Voltage regulation of the high-voltage outputs is accomplished by regulating the amplitude of oscillations in the Hartley oscillator. The —1850-volt output is referenced to the +350-volt regulated supply through a voltage divider composed of R841, R842, R843, R845, R846, R847, R853 and variable resistors R840 and R846. Through a tap on the voltage divider, the regulator circuit samples the —1850-volt output of the supply, amplifies any errors and uses the amplified error voltage to adjust the screen voltage of Hartley oscillator V800. If the —1850-volt output changes, the change is detected at the grid of V814B. The detected error is amplified by V814B and V814A. The error signal at the plate of V814A is direct coupled to the screen of V800 by making the plate-load resistor of V814A serve as the screen-dropping resistor for V800. Any change in the —1850-volt output thus changes the screen voltage of V800 and the amplitude of the 50-kc oscillations. R840 provides a means of controlling the high-voltage output through controlling oscillation amplitude.

**Crt Grid Supply.** The approximately —1950-volt output of the high-voltage power supply is the rectified output of one of the two high-voltage secondaries on T801. To provide dc-coupled unblanking signals to the crt grid, the crt grid supply is floating (the dc voltage levels on the components shift in accordance with the unblanking signals). The positive side of the crt grid supply is returned to the —150-volt supply through the unblanking cathode-follower load resistor of the selected sweep generator and through R831 and R832. The negative side of the crt grid supply is applied through the INTENSITY control to the crt grid.

At the fastest sweep rates, the stray capacitance of the floating crt grid circuit makes it difficult for the crt grid to rise fast enough to unblank the crt in the required time. An isolation network consisting of R827, R828, C828, C829, and C830 isolates the capacitive loading. By this arrangement, the fast leading edge of the unblanking pulse is coupled through C830 and C828 to the grid of the crt. For short-duration unblanking pulses, such as those that occur at the fastest sweep rates, the dc levels on the rectifier and secondary winding are not appreciably affected. Longer unblanking pulses, such as those that occur at the slower sweep rates, charge the stray capacitance in the —1950-volt output through R827. This pulls up the floating crt grid circuit and holds the crt grid at the unblanked potential for the duration of the unblanking pulse.

**+8150- and —1850-Volt Outputs.** Both the +8150- and the —1850-volt outputs are derived from the same secondary winding on T801. The full secondary voltage of approximately 2900 volts is applied to a voltage tripler consisting of rectifiers V832, V842, and V852 and associated capacitors. A tap on the secondary provides the input for half-wave rectifier V862 in the —1850-volt output. Both outputs are referenced to the regulated +350-volt supply through a voltage divider network. The +8150-volt output is connected to the crt post-deflection-accelerator anode and the —1850-volt output is connected to the crt cathode, providing a total accelerating voltage of 10,000 volts.

**Crt Circuit Controls and Connectors.** Optimum size and shape of the flourescent spot on the crt is obtained by adjusting the front-panel FOCUS and ASTIGMATISM controls. FOCUS control R846 provides the correct voltage for the second anode (focus ring) in the crt. Proper voltage for the third anode is obtained by adjusting ASTIGMATISM control R864. In order to obtain optimum spot size and shape, both the FOCUS and ASTIGMATISM controls are adjusted to provide the proper electronic lens configuration in the region of the second and third anodes of the crt. Spot intensity is adjusted by means of front-panel INTENSITY control R826. Varying the INTENSITY control changes the voltage on the crt grid, which in turn varies the density of the electron stream. Internal GEOMETRY control R861 adjusts the isolation shield voltage in the crt, and is adjusted to minimize "bowing" or "tilting" of the display. Front-panel TRACE ROTATION control R778 permits minor adjustments in trace orientation. By adjusting the TRACE ROTATION control, the trace can be made parallel with the horizontal lines on the graticule, eliminating the need to physically turn the crt to correct for minor deviations of the trace from the horizontal.

An input binding post on the rear panel of the Type 546 provides an input for externally modulating the crt cathode. The input binding post is normally grounded by a link. If it is desired to intensity modulate the display from an external source, the link is opened, and the modulating signal is coupled to the crt cathode through C858.

When the Type 546 is used with a multichannel vertical plug-in preamplifier that provides dual-trace chopped blanking pulses, the blanking pulses are applied to rear-panel CRT CATHODE SELECTOR switch SW858. With the vertical plug-in preamplifier operating in the chopped mode and SW858 set to the CHOPPED BLANKING position, a positive pulse of approximately 20-volts amplitude is applied through C858 to the cathode of the crt. At normal intensity levels, this pulse is sufficient to cut off the crt during the time the amplifier channels in the vertical plug-in preamplifiers are being switched.

## Vertical Amplifier System

The vertical amplifier system in the Type 546 consists of an appropriate vertical plug-in preamplifier, a push-pull cathode-follower input stage, a push-pull transistorized delay-line driver, a delay line, and a push-pull transistorized output amplifier. In addition, the trigger-pickoff circuit functions as a part of the vertical amplifier by providing reverse termination for the delay line.

**Vertical Input Amplifier.** The push-pull output of the vertical plug-in preamplifier, with a fixed dc level of approximately +67.5 volts, is applied to the input of the vertical amplifier through terminals 1 and 3 of the plug-in connector.

Transient-response compensation switch SW1000, capacitor C1000, and resistor R1000 at the input of the vertical amplifier compensate for the difference in transient response that

exists between different models of vertical plug-in preamplifiers. SW1000 is actuated by a mechanical sensing device when the plug-in unit is inserted into the oscilloscope, and requires no attention on the part of the operator.

R1001 and R1011, in series with the grids of the push-pull cathode-follower stage, are parasitic suppressors. Input cathode followers V1003A and V1003B are the two halves of a 12AT7 twin triode. The cathodes of the cathode followers are returned to ground through vertical dc balance control R1004, which is adjusted to equalize the dc voltage (about +68.5 volts) on the bases of delay-line driver transistors Q1014 and Q1024. The heaters of V1003 are operated as part of the series string which receives power from the +100-volt dc supply. The use of dc on the heaters prevents changes in line voltage from affecting the gain of the vertical amplifier.

The balanced delay-line driver stage is a push-pull amplifier with an adjustable vertical gain control (R1017) connected in the emitter circuit of the two transistors. Gain is adjusted by controlling the amount of degeneration in the emitter circuit. Zener diode D1018 sets the operating points of the termination transistors on both ends of the delay line. The rc networks in the collectors of Q1014, Q1024, Q1144, Q1154, and in the emitter leads of Q1034 and Q1044 set the individual transistor operating points to achieve thermal balance. The 5-turn center-tapped coils at the input of the delay line and the collector-base capacitance of the delay-line driver transistors form a T-section matching network. C1029 provides a means of varying the impedance of the T section.

**Vertical Output Amplifier.** The vertical output amplifier must properly terminate the delay line and provide broad-band amplification of the vertical signals. Proper termination of the delay line is obtained by connecting forward-termination transistors in a common-base configuration. The common-base configuration also operates well in broad-band amplifier applications. To help meet the broad-band requirement, the collector load circuit of the termination transistors contain rc low-frequency compensation networks, and in addition, lr networks in the collectors of transistors Q1034 and Q1044 compensate for losses due to skin effect within the delay line.

Following the forward-termination amplifier is a wide-band amplifier stage consisting of Q1074 and Q1084 and associated elements. High-frequency compensation in this stage is provided by shunt peaking coils L1072 and L1082 in the collector circuits. The high-frequency response is varied by adjusting C1076, which provides variable high-frequency degeneration in the emitter circuit of Q1074 and Q1084.

The output stage of the vertical amplifier is a transistorized equivalent of a push-pull cascode amplifier. This circuit configuration is used to match the low impedance of the transistorized vertical-amplifier system to the higher impedance required at the crt vertical deflection plates. High-frequency compensation is provided by rc networks between the collector of the driving transistor and the emitter of the driven transistor on each side. C1105 and C1106 provide a means of varying the high-frequency response of the output stage. The outputs from Q1114 and Q1134 are connected to the deflection plates of the crt via series-peaking coils L1115 and L1135.

**Trigger-Pickoff Circuit.** The trigger-pickoff circuit provides reverse termination for the delay line as mentioned in the preceding paragraphs. The input stage of the trigger-pickoff circuit, which provides the delay-line reverse termination, is a common-base circuit. The output stage of the trigger-pickoff circuit is a push-pull emitter-follower amplifier that not only provides trigger signals to the two time bases, but supplies the VERT SIG OUT jack with a vertical signal and drives position-indicator amplifier V1184.

## Main Time Base (B)

The Main Time Base (B) consists of the B sweep trigger and the B sweep generator circuits. The B sweep trigger circuit is a wide-band hybrid amplifier driving a tunnel diode. The B sweep trigger circuit includes controls for selecting the type, source, and level of the trigger to be used, and circuit elements for regenerating the selected trigger into a pulse suitable for triggering the B sweep generator. The B sweep generator provides ramp voltages for the horizontal deflection system, alternate-trace sync pulses, unblanking pulses, and +B gate pulses.

**Trigger Generator.** The input to the B sweep trigger circuit (see B Sweep Trigger schematic) is selected by SOURCE switch SW1 from the trigger-pickoff circuit in the vertical amplifier, the trigger output of the vertical plug-in preamplifier, the power transformer for line triggering, or from the front-panel TRIGGER INPUT connector. COUPLING switch SW5 permits further selection of the type of triggering signal; either ac, ac with low frequencies rejected, or dc. Once the type and source of triggering signal has been selected, the slope on which triggering is desired is selected by SLOPE switch SW10. The level of the triggering signal required by the B sweep trigger circuit is selected by adjusting TRIGGERING LEVEL control R15. After this triggering signal has been selected by the foregoing controls and switches, it is applied to trigger input amplifier V24.

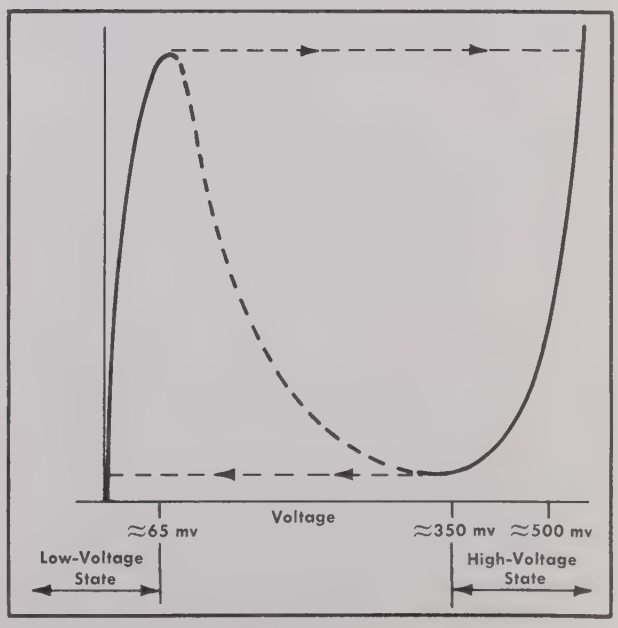



Fig. 3-2. Tunnel diode characteristics.

In operation, V24A and V24B form a push-pull amplifier which drives a push-pull input, single-ended output amplifier consisting of Q34 and Q44. Tunnel diode D45 is biased at its low-voltage state (see Fig. 3-2 for trigger tunnel-diode curve) by current flow through the voltage divider consisting of R44, R45, R47, and R48. When the desired slope of the triggering signal selected arrives at the grids of V24, V24B and Q44 are biased into conduction. The conduction of Q44 increases the current flow through D45, and D45 switches to its high-voltage state. The sudden voltage change across D45 as it switches to its high-voltage state produces a uniform fast-rising trigger pulse which is used to trigger the Main Time Base (B) sweep generator.

**Sweep Generator.** For purposes of explanation, assume that the HORIZONTAL DISPLAY switch (see B Sweep Generator schematic) is in the B position, the SINGLE SWEEP switch is in the NORMAL position, the TRIGGERING MODE switch is in the TRIG position and that no trigger is being applied. Under these conditions, V145A in the holdoff multivibrator is conducting and V145B is cut off. The paths for the current in V145A are from the —150-volt supply through R164 and D163 in parallel with R163. When V145A is conducting and no trigger is being received from the trigger generator, D85 is in its low-voltage state since the dc current supplied from the +100-volt supply through R82 and R81 is less than the peak current of D85. Under these conditions, Q84 is cut off. Thus, the collector voltage of Q84 is positive, forward biasing D86, Q89 and Q103. Miller tube V91 is conducting. The circuit is now ready to be triggered.

Assuming that a trigger pulse is now applied, the positive trigger from the B sweep trigger circuit is coupled through C56 to L56 and D57. C56 and L56 form a differentiating network that narrows the trigger pulse to approximately 4 nsec in width. The sharpened trigger pulse passes through D59 to tunnel diode D85 and causes D85 to switch to its high state, where it remains after the trigger pulse decays to zero. When D85 switches to its high state, Q84 is biased into saturation and the voltage change across Q84 applies forward bias to Q173 and reverse biases Q89, Q103, and D86. When D86 is reverse biased, the voltage on the grid of V91 goes negative and the Miller circuit starts to run up. As the voltage on the cathode of V93A goes positive, it starts to charge timing capacitor C90 through D98. At high sweep rates, boot-strap capacitor C94 couples the rising cathode voltage to the plate circuit of V91 and effectively increases the plate supply voltage for V91, compensating for losses introduced by stray capacitance. In addition, the positive-going cathode voltage of V93A forward biases D129 and starts putting a positive voltage on the grid of V145B in the holdoff multivibrator. At a point determined by sweep-length resistor R125, the rising positive voltage biases V145B into conduction, and the holdoff multivibrator changes state, cutting off V145A. When V145A cuts off, its cathode voltage drops to —20 volts and reverse biases D85 and Q84. As current flow through Q84 ceases, the voltage increase across it again forward biases D86. When D86 becomes forward biased, it applies a positive-going voltage to the grid of V91 which resets the Miller circuit and ends the sweep.

Disconnect diode D100 ensures that the sweep starts from the same voltage point each time. Q103 is included in the circuit to reduce the amount of current that D100 has to switch, and thereby improves the linearity at the start of the sweep.

When the sweep ends, V145B has control of the holdoff multivibrator, and remains in control until the charge on holdoff capacitor C130 discharges through R130. During the time that V145B has control of the holdoff multivibrator, tunnel diode D85 cannot be triggered; but when the holdoff capacitor discharges to the point where V145A can again assume control, D85 is again biased to a point where it can accept another trigger.

**Automatic Stability Circuit.** Q65, Q75, and associated circuit components form a monostable multivibrator that controls the stability of the B sweep generator. When the trigger MODE switch is in the TRIG position, the switch grounds the collector of Q75 and disables the automatic stability feature of the Type 546. When the triggering MODE switch is in the AUTO STABILITY position, the sweep generator free runs if no trigger pulses are received from the trigger generator.

In normal operation Q65 is conducting due to the positive voltage applied to its base. Q75 is normally cut off due to its base being grounded through R69. When the trigger MODE switch is set to the AUTO position, C76 starts to charge through R76. When the voltage across C76 exceeds the break-down of Zener diode D76, D76 breaks down and provides an additional current path for tunnel diode D85. The additional current through D85 causes it to switch to its high state and start the sweep. When the sweep ends and the holdoff multivibrator switches, the voltage on the cathode of V145A drops to approximately —20 volts, reverse biasing D85. When the holdoff period ends, the cathode voltage of V145A goes slightly positive, and the current through D76 again switches D85. If no trigger is applied, the cycle repeats only if the trigger MODE switch is in the AUTO position.

When a trigger pulse is received at T52, a negative output from the secondary is applied to the base of Q65 and causes the monostable multivibrator to switch. With Q65 now cut off, its collector voltage goes more positive, and C67 charges through R69, applying a positive voltage to the base of Q75. The positive voltage on the base of Q75 biases it to saturation, and Q75 provides a low-resistance path that discharges C76 and reverse biases D79 and D76. With the collector of Q75 below the D76 breakdown voltage, the collector circuit does not provide switching current for tunnel diode D85, so the only way D85 can be switched is by the application of a trigger pulse. If no further trigger pulses are received, Q75 is kept in saturation until the charge current for C67 decays and removes the positive voltage from the base of Q75.

During the charge time of C67, Q65 is kept cut off by the forward voltage drop across D71. When the decaying charge current removes saturation bias from Q75, the voltage drop across D71 decreases and permits Q65 to conduct, and the multivibrator switches back to its normal state. If no further trigger pulses are received, C76 charges through R76 and R75 until D76 again breaks down and provides switching current for D85.

**Unblanking Circuit.** With the HORIZONTAL DISPLAY switch set in the B position, an unblanking pulse is generated and applied to the crt unblanking circuit during B sweep time. The unblanking pulse is initiated when tunnel diode D85 switches to its high state and biases Q84 into conduction. When Q84 conducts, its collector voltage drops and removes the cutoff bias from Q173, biasing Q173 into conduction. When Q173 conducts, it puts a positive-going voltage on the

grids of cathode followers V193A and V193B. The positive-going voltage on the cathode of V193B is coupled to the crt-unblanking supply. The output of V193A is applied to the +GATE B connector on the front panel and to pin C of J435.

**Single-Sweep Circuit.** When single-sweep operation is desired, NORMAL - SINGLE SWEEP - RESET switch SW135 is set to the SINGLE SWEEP position. When SW135 is pushed to the RESET position, it operates switch SW369 which discharges C369 (see A Sweep Generator schematic) through R369, R368, and R367, generating a positive pulse which is applied through C166 and D164 to the cathode of holdoff tube V145B. The positive pulse on the cathode of V145B causes the holdoff multivibrator to switch, and V145A biases sweep tunnel diode D85 to the ready point as previously explained. Since Q84 and V145B are both cut off, the positive voltage on the collector of Q84 and the voltage on the plate of V145A combine through R87 and R142 and produce turn-on bias for Q89. When Q89 conducts, it completes the circuit for the NE-23 READY lamp (B89). With the application of a trigger pulse, Q84 conducts and the voltage on its collector drops, removing the bias on Q89 and thereby extinguishing the READY lamp. The runup of the Miller circuit causes the hold-off multivibrator to switch, and V145B takes control. NORMAL - SINGLE SWEEP - RESET switch SW135 applies a positive voltage through D132 to the grid of V145B, and this positive voltage prevents the holdoff multivibrator from resetting until NORMAL - SINGLE SWEEP - RESET switch SW369 has been moved to either the RESET or NORMAL position.

**Main Time Base (B) Sweep Timing.** The sweep rate (the rate at which the spot moves across the face of the crt) is determined by the rate at which the timing capacitor and timing resistor permit the Miller circuit to run up. By means of TIME/CM OR DELAY TIME switch SW90 (see B Sweep Timing-Switch schematic), both the size of the capacitor being charged and the charging current can be selected to cover a wide range of sawtooth slopes (sweep rates). Note that SW90 is connected so that switching 8 capacitors and 6 resistors provides 24 different sweep rates, varying from 5 sec/cm to 0.1 μsec/cm without magnification. The TIME/CM OR DELAY TIME switch also selects the proper holdoff capacitor and discharge resistor for the sweep rate in use.

Continuously variable uncalibrated sweep rates are provided by R90Z and SW90Z (VARIABLE control). When SW90Z is switched to the UNCAL position, it removes the short from around R90Z and switches on UNCAL lamp B90W. By turning VARIABLE control R90Z, the charging time of the timing capacitor selected by the TIME/CM OR DELAY TIME switch may be increased by at least 2.5 times the calibrated rate, providing continuously variable sweep rates.

**Delay-Pickoff Circuit.** The delay-pickoff circuit (see Delay Pickoff schematic) generates a trigger pulse that is delayed from the start of the B sweep by an amount determined by the settings of the Main Time Base (B) TIME/CM OR DELAY TIME switch and the DELAY TIME MULTIPLIER dial. A comparator in the delay-pickoff circuit continuously monitors the ramp output voltage of the Main Time Base (B) Miller runup circuit and compares the ramp voltage with a voltage level established by the setting of the DELAY TIME MULTIPLIER dial. When the ramp voltage biases V404A into conduction, the comparator switches a tunnel diode. The tunnel diode generates a trigger pulse that is delayed from the start of the B sweep by the time it takes the ramp voltage to rise to a value approximately equal to the voltage established by the DELAY TIME MULTIPLIER dial setting. After being amplified, the delayed trigger is applied through the HORIZONTAL DISPLAY switch as a source of delayed trigger for the Time Base A generator, and to the DLY'D TRIG output connector on the front panel for use in external equipment. Delayed trigger pulses are connected to the Time Base A sweep generator when the HORIZONTAL DISPLAY switch is in the B INTEN BY A and A DLY'D BY B positions.

In actual operation, the comparator is longtailed through a constant-current tube that keeps the current through the comparator relatively constant despite the large voltage swings applied to the grids. The grid voltage of constant-current tube V93A is fixed at approximately —56 volts by the voltage divider consisting of R406 and R407. With the grid of V93A biased at approximately —56 volts, R409 maintains the current through V93B (and thereby the comparator tube) to approximately 5 ma.

Comparator tube V404 receives the ramp output of the Main Time Base (B) sweep generator on one grid and the voltage from the tap on delay-time helipot R416 on the other. At the start of the ramp, V404B is conducting and V404A is cut off. Assume that the ramp input to the comparator is increasing at the rate of 10 volts/msec, and the DELAY TIME MULTIPLIER dial is set at 2.0 (2.0 is equal to 20 volts of a 100-volt ramp), then the voltage on each grid of the comparator becomes 20 volts 2 msec after the ramp starts. At this point, V404A starts conducting. V404A draws current through R404, L404 and tunnel diode D405. The current flow through D405 causes it to switch to its high state, generating a sharp trigger pulse. R404 and L404 narrow the hysteresis zone of D405. The low resistance of R404 would attenuate the trigger pulse if it were not for the high-frequency peaking effect of L404. The trigger voltage developed across D405 is amplified by Q424 and applied to Q433 through a differentiating network. The output of Q433 is applied to the DLY'D TRIG connector on the front-panel and to the HORIZONTAL DISPLAY switch as previously mentioned.

Jack J435 provides a means of coupling in an externally-generated delayed trigger. Terminals B and C provide function information to the external trigger generator, and the externally-generated delayed trigger is applied to terminal A. It is also necessary to apply sufficient dc bias to terminal A to back bias D433.

## Time Base A

Time Base A in the Type 546 is similar to the Main Time Base (B) sweep generator and the circuit description of the operations of Main Time Base (B) generally applies to Time Base A. The two trigger generator schematics, in particular, show few differences other than circuit symbols. The major circuit differences in the two time bases are the Single Sweep switch, the delayed sweep lockout circuits, and cathode follower V293B which appear on Time Base A schematic but not on B. Cathode follower V293B provides a sample of the A sweep ramp to the front panel; the functions of the Single Sweep switch and delayed sweep lockout circuits for each setting of the HORIZONTAL DISPLAY switch are given in the following paragraphs.

**Position A.** With the HORIZONTAL DISPLAY switch in this position and the Single Sweep switch in the NORMAL position, the operation of Time Base A is the same as the operation of the Main Time Base (B) when the HORIZONTAL DISPLAY switch is in the B position as previously described. If the Single Sweep switch is placed in the SINGLE SWEEP position, Time Base A operates as follows:

The holdoff multivibrator is armed by pressing the Single Sweep switch to RESET or by feeding in an external reset signal through EXTERNAL SINGLE SWEEP INPUT jack J367. The reset pulse cuts off V345A and makes V345B the conducting half of the holdoff multivibrator. If the Time Base A TRIGGERING MODE switch is in the AUTO position, the sweep triggers automatically. If the TRIGGERING MODE switch is in the TRIG position, the sweep triggers on the next trigger pulse from the A Sweep Trigger Generator. Once the sweep runs up, the positive voltage at the junction of R331 and R332 keeps the holdoff multivibrator in holdoff until it is again armed by a reset pulse from the Single Sweep switch or from the external single sweep input.

**Position B.** In this position of the HORIZONTAL DISPLAY switch, Time Base A operates in the same manner as described for the A position, but the A sweep is not applied to the horizontal amplifier and does not appear on the crt.

**Position B INTENS BY A.** In this position of the HORIZONTAL DISPLAY switch the external single sweep reset feature is disabled by wafer 3F. The auto circuit is disabled by wafer 4R. Wafer 5R connects the holdoff capacitor to a positive voltage source to increase the holdoff time. With the TRIGGERING MODE switch in the AUTO position, the MODE switch grounds the junction of R334 and R335, removing the lockout voltage from V345A in the holdoff multivibrator. With the lockout voltage removed, the holdoff multivibrator arms tunnel diode D285 at the end of holdoff time. Triggering signals from the A sweep trigger generator cannot get through D259 since it is reverse biased due to wafer 4R and the MODE switch grounding the bottom end of R258. When the holdoff multivibrator arms at the end of the holdoff period, the next delayed trigger from the delayed trigger circuit passes through C361 and R361 and causes D285 to switch, starting the delayed sweep. The output of the A sweep generator is grounded by the HORIZONTAL DISPLAY switch and does not get to the horizontal amplifier, but the output of V393B is applied to the crt grid and intensifies B sweep during the time the delayed A sweep is running.

At the end of A sweep, it is necessary to keep B sweep from running again until A sweep is out of holdoff. When V345B is in holdoff, its cathode voltage goes negative. The negative voltage on the cathode of V345B is coupled through wafer 4F to diode D57 in the Main Time Base (B) generator. The negative voltage from the cathode of V345B reverse biases diodes D57 and D59, preventing any triggering signals from reaching D85 until the sweep circuit of Time Base A is again armed and ready for a trigger.

When it is desired to display a single sweep of B INTENS BY A, the SINGLE SWEEP switch is placed in the SINGLE SWEEP position. Main Time Base (B) generator stays in holdoff due to the positive voltage from the junction of R331 and R332 through wafer 1R to Main Time Base (B) holdoff capacitor. Setting the Single Sweep switch to RESET causes the Main Time Base (B) holdoff multivibrator to switch, arming the main time base. With the application of a trigger pulse, B sweep runs up. If Time Base A TRIGGERING MODE switch is in AUTO, Time Base A holdoff multivibrator arms automatically and the intensified segment of the sweep starts when the delayed trigger pulse occurs. If the TRIGGERING MODE switch is in the TRIG position, the holdoff multivibrator stays in holdoff until the arrival of the delayed trigger pulse. This is due to the voltage at the junction of R334 and R335 being applied to the grid of V345A. When the delayed trigger occurs, Time Base A holdoff multivibrator arms and waits until it is triggered by a trigger pulse from Time Base A trigger generator.

**Position A DLY'D.** The operation of Time Base A sweep generator in this position of the HORIZONTAL DISPLAY switch is the same as described for B INTENS BY A. However, in this position of the HORIZONTAL DISPLAY switch, the output of Time Base A generator is applied to the horizontal amplifier while the output of Main Time Base (B) is grounded, and only the delayed A sweep is displayed.

**EXT Positions.** In these positions of the HORIZONTAL DISPLAY switch, the outputs of both sweep generators are grounded, and it is necessary to apply an external signal to the HORIZ INPUT jack on the front panel in order to get a horizontal sweep.

## Alternate-Trace Sync Amplifier

The alternate-trace sync amplifier (see Interconnecting Jack J11 schematic) amplifies and shapes the alternate-trace sync pulses from the sweep generator holdoff multivibrator and applies them to the vertical plug-in preamplifier. It also provides a sample of the pulse to the crt for blanking purposes.

## Horizontal Amplifier

The dc-coupled horizontal amplifier (see Horizontal Amplifier schematic) consists of a transistor input amplifier, an emitter follower, a transistor paraphase amplifier, a push-pull vacuum-tube output amplifier, a pair of output cathode followers, and a capacitance-driver tube. In addition, the Type 546 contains a cathode-coupled preamplifier that is used to amplify externally applied horizontal deflection signals. The input to the horizontal amplifier is received from the A sweep generator, B sweep generator, or the external HORIZ INPUT connector, depending upon the setting of the HORIZONTAL DISPLAY switch.

**Input Stages.** The selected input signal is applied to the base of Q534 along with dc-positioning voltages from the horizontal positioning controls. The composite signal output of Q534 is applied to emitter follower Q543, and from that transistor to the paraphase amplifier. Negative feedback from the emitter of Q543 to the base of Q534 keeps the input and output impedance of the two stages low. R544 (X10 CAL) in the feedback loop provides a means of adjusting the amount of feedback, thereby providing amplifier gain adjustment.

**Paraphase Amplifier.** Q554, Q564 and associated circuit components form a paraphase amplifier that splits the signal from Q543 into a push-pull output. The signal from Q554 to Q564 is coupled through the emitter circuit, and by changing the value of the coupling resistor, the gain of the para-

phase amplifier is changed to provide sweep magnification. Four selectable values of coupling resistor are available, providing X1, X2, X5, or X10 sweep magnification.

The feedback loop from the collector of Q554 stabilizes the gain and balance of the paraphase amplifier. D542 and D561 provide base-operating bias. The feedback loops from the output cathode followers (V574B and V584B) to the emitters of Q554 and Q564 assist in stabilizing the gain of the horizontal amplifier.

**Output Amplifier and Cathode Followers.** The ramp-voltage outputs of the paraphase amplifier are applied to the grids of amplifiers V574A and V584A. The ramp voltages are amplified by the two triodes, which then apply the ramp voltages to the output cathode followers. To maintain the desired linearity at high sweep rates, part of the output from each amplifier is bypassed around the cathode followers through small variable capacitors C572 and C582. C576 and C586 together with the stray capacitance across R576 and R586 form a capacitance bridge to provide correct high-frequency feedback.

**Capacitance Driver.** The cathode of V574B drives the left-hand deflection plate and, during the sweep, the cathode voltage should go linearly in a negative direction. At high sweep rates, when V574B tries to drive the deflection plate negative, the deflection-plate capacitance and the output capacitance of cathode follower V574B tend to distort the ideal linear ramp voltage into an rc discharge curve. To overcome this tendency toward nonlinearity, the positive-going ramp voltage at the cathode of V584B is applied through C591 to the grid of capacitance driver tube V589. The positive-going voltage on the grid of V589 forces it into heavy conduction, and the current supplied through the tube provides extra current to the cathode of V574B and helps to discharge the capacitance in the output of V574B. Since the crt is blanked during the return trace, there is no need for a similar current driver at the cathode of V584B.

**External Horizontal Preamplifier.** The preamplifier applies external horizontal deflection voltages through the HORIZONTAL DISPLAY switch to the grid of V514B. For large-amplitude signals, a X10 attenuator position is provided on the HORIZONTAL DISPLAY switch. V514B and V514A form a cathode-follower grounded-grid amplifier, with a gain controlled by adjusting the value of the coupling resistor between the two cathodes. In this case, R511 provides at least a 10:1 range of adjustment. The output of V514A is applied through the HORIZONTAL DISPLAY switch to the base of Q534.

## Amplitude Calibrator

The amplitude calibrator in the Type 546 is a 1-kc square-wave generator (see Amplitude Calibrator schematic) that provides both voltage and a 5-ma current output to the front-panel connectors. The voltage output is taken from the CAL OUT connector on the front panel, where either a selectable-amplitude square wave or a steady +100-volt dc reference voltage is available. By turning the AMPLITUDE CALIBRATOR switch, the amplitude of the square-wave output may be varied from 0.2 mvolts to 100 volts, peak-to-peak. The current output is applied to the current strap 5 mA, the arrow indicates conventional current flow. When the AMPLITUDE CALIBRATOR switch is in the 100 VDC position, the link has 5 ma dc flowing through it; when the switch is in the 5 mA position, the current through the link is in the form of a 1-kc, 5-ma square wave.

CAUTION

**The link is designed for use with a snap-on current probe and does not unplug.**

**Square-Wave Generator.** The square-wave generator is an astable multivibrator direct-coupled to a cathode follower. V935A and V945 are the multivibrator tubes, with the screen of V945 serving as an anode and furnishing feedback to V935A. The plate of V945 operates as an electron-coupled amplifier. The time constants in the grid circuits of the tubes are different to compensate for the difference in their characteristics. When the amplitude calibrator is turned on, the multivibrator cathodes are returned directly to the dc-coupled —150-volt supply. Since the plate load and grid resistors are grounded, this means that the supply potential of the multivibrator is 150 volts. The plate of V945 operates from the +225-volt supply, but is clamped slightly above 100 volts by D942 and D948. The voltage on the plate of V945 swings from about —30 volts to about +102 volts. The plate of V945 is coupled through Zener diode D948 to the grid of cathode follower V935B. CAL AMPL control R943 is adjusted so that when the signal to V935 is positive, its cathode voltage rises to +100 volts. When the signal from the V945 plate goes negative, V935B is cut off and the cathode voltage goes to ground potential.

**Output Level Selection.** The cathode load for V935B is essentially the string of precision resistors starting with R950 and ending with R958. The junctions of the precision resistors are connected to the CAL OUT connector through AMPLITUDE CALIBRATOR switch SW950. The values of the precision resistors are selected to give output amplitude steps in multiples of 1, 2, or 5. In the steps from 200 mvolts to 100 volts, the junctions of the precision resistors are switched through R962 to the CAL OUT connector, while in the steps from 0.2 to 100 mvolts, an additional divider with a ratio of 1000:1 is inserted between the precision resistors and the CAL OUT connector. In the 0.2 mvolt to 200 mvolt range, the output impedance is 50 Ω.

# SECTION 4

# MAINTENANCE

## PREVENTIVE MAINTENANCE

CAUTION

Turn off power before removing or replacing parts.

### General Information

The Type 546 is a stable instrument and will provide many hours of trouble-free operation. However, to maintain measurement accuracy, a visual inspection and a calibration check should be made after each 500 hours of operation or every six months if used intermittently. The calibration procedures include steps for checking the operation of various circuits. Minor troubles not apparent during regular operation will often be revealed during calibration. Major troubles in the instrument are often isolated or eliminated by recalibrating the instrument.

### Visual Inspection

The Type 546 should be inspected occasionally for such defects as broken connections, broken or damaged ceramic strips, improperly seated tubes or transistors, and heat damaged parts. The remedy for most visible defects is obvious; however, particular care must be taken if heat-damaged parts are detected. Overheating is usually only a symptom of trouble. For this reason, it is essential to determine the actual cause of overheating before the heat-damaged parts are replaced; otherwise, the damage may be repeated.

### Cleaning

The Type 546 must be cleaned as often as operating conditions require. Accumulations of dirt in the instrument can cause overheating and component breakdown. Dirt on the components acts as an insulating blanket (preventing efficient heat dissipation) and provides conducting paths for electricity. Dirt in the air filter chokes the flow of cooling air and leads to excessive operating temperature.

**Air Filter.** The air filter should be visually checked every few weeks and cleaned if dirty. More frequent inspections and cleaning are required under severe operating conditions. To clean the filter, wash it out as you would a plastic sponge. Rinse the filter, and let it dry. Coat the dry filter with fresh "Filter-Kote" (Tektronix Part Number 006-580) or "Handi-Koter." (These products are available from the local representative of the Research Products Corporation, and from some air-conditioner suppliers.) Let the filter dry thoroughly before reinstalling.

**Exterior.** Loose dust accumulating on the outside of the Type 546 can be removed with a cloth or small paint brush. The paint brush is particularly useful for dislodging dust on and around the front-panel controls. Stubborn dirt can be removed with a soft cloth dampened in a mild solution of water and detergent. Abrasive cleaners should not be used.

Clean the face of the crt with a soft, lint-free cloth dampened with denatured alcohol.

**Interior.** Although the air entering the Type 546 is filtered, some dust will eventually penetrate into the interior of the instrument. This dust should be removed occasionally due to its conductivity under high humidity conditions. The best way to clean the interior of the equipment is to first carefully vacuum all accessible areas and then blow away the remaining dust with dry low-pressure compressed air. Avoid the use of high-velocity air which might damage some of the components. Remove stubborn dirt with a soft paint brush or a cloth dampened with a mild water and detergent solution.

Pay special attention to high-voltage circuits, including parts inside the high-voltage shield. Arcing in the high-voltage circuits due to dust or other causes may produce false sweep triggering resulting in an unstable crt display.

### Lubrication

The fan motor bearings should be lubricated every three or four months with a few drops of light machine oil (see Fig. 4-1). Failure to lubricate the bearings periodically can cause the fan to slow down or stop.

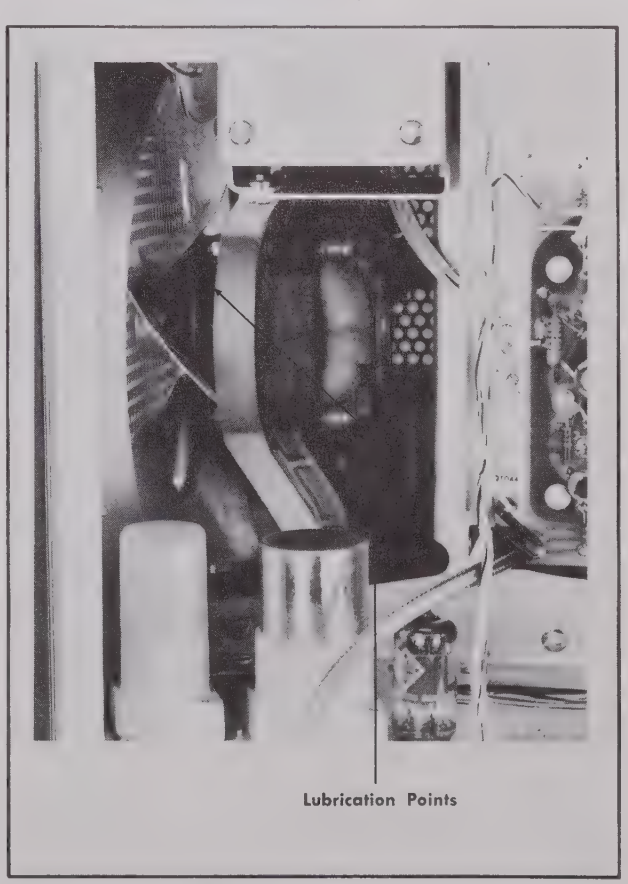



Fig. 4-1. Fan motor lubrication points.

# CORRECTIVE MAINTENANCE

## General Information

Many components in the Type 546 are mounted in a particular way to reduce stray inductance and capacitance. While removal or replacement procedures for most parts in the Type 546 are obvious, remember to duplicate lead length, lead dress, and location of the original component when installing replacement parts. Since components of the same type may exhibit slightly different characteristics, it is desirable to check the calibration of the Type 546 after completion of repairs.

## Component Numbering

The component number of each electrical part is shown on the circuit diagrams. The following chart lists the component numbers associated with each circuit.

| | |
|---|---|
| numbers less than 100 | B Sweep Trigger Circuit |
| 100-series numbers | B Sweep Generator |
| 200-series numbers | A Sweep Trigger Circuit |
| 300-series numbers | A Sweep Generator Circuit |
| 400-series numbers | Delay Pickoff Circuit |
| 500-series numbers | Horizontal Amplifier Circuit |
| 600- and 700-series numbers | Low-Voltage Power Supply |
| 800-series numbers | Crt Circuit |
| 900-series numbers | Calibrator |
| 1000- and 1100-series numbers | Vertical Amplifier |

## Soldering Precautions

In the production of Tektronix instruments, a special silver-bearing solder is used to establish a bond to the ceramic terminal strips. This bond may be broken by repeated use of ordinary tin-lead solder, or by excessive heating of the terminal strip with a soldering iron. Occasional use of ordinary 60-40 solder will not break the bond unless excessive heat is applied, but it is advisable to stock solder containing about 3% silver for the maintenance of Tektronix instruments. This solder may be purchased directly from Tektronix in one-pound rolls; order by Part Number 251-514.

Because of the shape of the ceramic-strip terminals, it is recommended that a soldering iron with a wedge-shaped tip be used. A wedge-shaped tip allows the heat to be concentrated on the solder in the terminals and reduces the amount of heat required. It is important to use as little heat as possible while producing a full-flow joint.

The following procedure is recommended for removing or replacing components mounted on ceramic strips:

1. Use a 50- to 75-watt soldering iron.
2. Tin the tip with solder containing about 3% silver.
3. Use long-nose pliers for a heat sink. Attach pliers between the component and the point where heat is applied.
4. Apply heat directly to the solder in the terminal without touching the ceramic. Do not twist the iron in the notch as this may chip or break the ceramic strip.
5. Apply only enough heat to make the solder flow freely.
6. Do not attempt to fill the notch on the strip with solder; instead apply only enough solder to cover the wires adequately and form a small fillet on the wire. Over-filling the notches may result in cracked terminal strips. If the lead extends beyond the solder joint, clip the excess as close to the joint as possible. Remove all wire clippings from the chassis.

## Tubes and Transistors

Tubes or transistors should not be replaced unless they are actually defective. If tubes or transistors are removed and found to be acceptable, be sure to return them to their original sockets. Tube or transistor-tester checks on the tubes or transistors used in the Type 546 are not recommended. Testers may indicate a tube or transistor to be defective when it is operating satisfactorily in a circuit, or may fail to indicate tube or transistor defects which affect the performance of the circuits. It is recommended that tubes and transistors be checked by substitution. If the tube or transistor is good, return it to its socket. Unnecessary replacement of tubes or transistors is not only expensive but may also result in needless recalibration of the instrument.

When installing replacement transistors on heat sinks in the instrument, the bottom of the transistor where it contacts the heat sink should be coated with silicone grease. If a heat sink has been replaced along with the transistor, then that area of the heat sink which contacts the chassis of the instrument should also be coated with silicone grease.

## Wafer Switches

Individual wafers are normally not replaced in the switch assemblies. If one wafer is defective, the entire switch assembly should be replaced. Switches can be ordered from Tektronix either wired or unwired. For wired and unwired part numbers, refer to the parts list in Section 6.

The wafer switches shown on the schematics are coded to indicate the position of the wafer on the switch. The wafers are numbered from front to rear (i.e., the number 1 wafer is always closest to the front panel). The letters F and R indicate the front or rear of the wafer. For example, a code designation of 3R means the rear side of the third wafer from the front panel.

## Cathode-Ray Tube

To remove and replace the cathode-ray tube, perform the following procedure:

WARNING

**Be careful when handling a crt. Avoid striking it on any object that might cause it to crack and implode. Flying glass from an imploding crt can cause serious injury. Use safety glasses or a plastic face mask for protection.**

1. Remove the crt bezel nuts, bezel, and plastic polarized light filter (see Fig. 4-2).
2. Remove plastic eyebrow and retaining spring from the top of the crt (see Fig. 4-2).

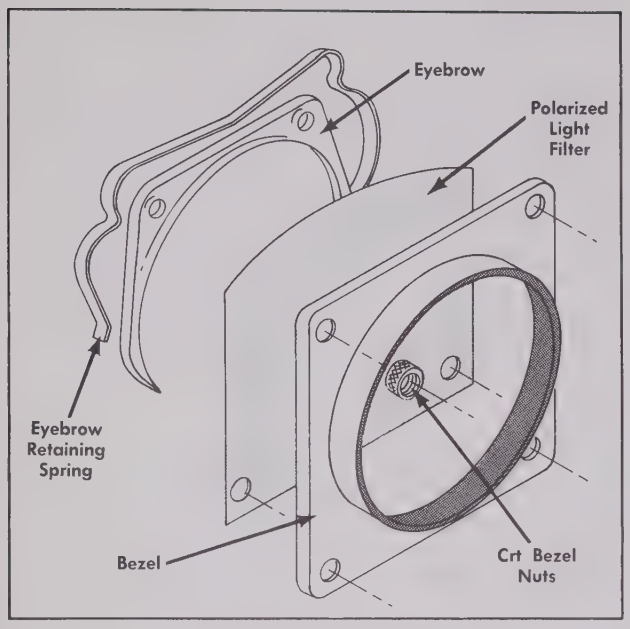



Fig. 4-2. Crt bezel and eyebrow arrangement.

3. Remove crt anode lead, disconnect all leads to the neck of the crt.

NOTE

Do not disconnect the crt trace-rotation coil leads.

4. Using a Phillips screwdriver, loosen the crt base clamp (see Fig. 4-3).

5. With your left hand, wiggle the crt socket (see Fig. 4-3) to ensure that the base of the crt is loose in the base clamp.

6. With a chisel-tipped plastic or wooden dowel, carefully work the crt socket loose from the crt base.

7. Grasp the face of the crt with the right hand. Push the crt carefully towards the front of the Type 546 with the left hand. Be careful not to bend the neck pins. Remove the crt through the front of the oscilloscope.

8. Before reinstalling the crt, dust talcum powder on the crt base. This keeps the base of the crt from sticking to the neoprene bushing inside the base clamp.

9. Carefully insert the new tube into the shield and the tube base clamp. Keep the anode button in line with the anode connector hole so that the button is aligned with the hole when the crt is fully inserted.

NOTE

Make sure that the crt base clamp is loose enough to permit the crt base to slide through the neoprene bushing inside the base clamp.

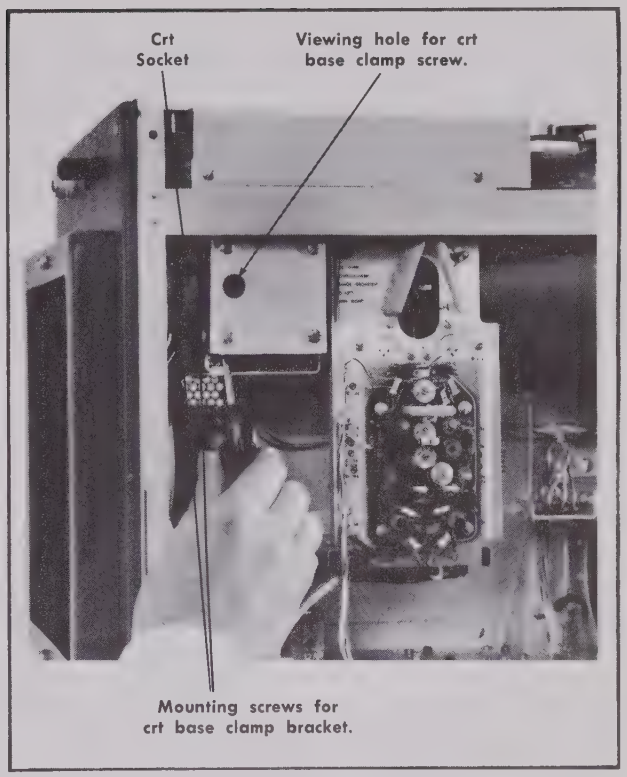



Fig. 4-3. Loosening the crt base clamp.

10. Connect the tube socket to the tube base. Check that the socket is fully seated.

11. Align the crt so that the horizontal graticule lines are parallel with the top of the front panel. Push the crt inward until the crt face protrudes $\frac{3}{16}$" beyond the front panel.

12. Reconnect the anode and neck-pin leads (observe color code).

NOTE

If the crt face is not parallel with the front of the oscilloscope, use a $\frac{7}{64}$" hexagonal wrench to loosen the two mounting screws that fasten the base clamp to its mounting bracket (see Fig. 4-3). The base clamp and crt base may now be removed radially to align the face of the crt parallel with the front of the oscilloscope.

13. Tighten the base clamp.

14. Turn on the oscilloscope. Obtain a free-running sweep on the crt.

15. Check the alignment of the trace with the graticule lines. If the trace is not parallel with the graticule lines, align the traces with the TRACE ROTATION control.

16. Replace the eyebrow, eyebrow retaining spring, plastic polarized light filter, crt bezel and bezel nuts.

## Graticule Lamps

Proper illumination of the crt graticule depends upon the proper positioning of the graticule lamps. When replacing graticule lamps, slide the lamp and socket in or out until the filament of the lamp is at the middle of the eyebrow thickness.

## Ceramic Terminal Strips

To remove a ceramic terminal strip, first unsolder all leads and components connected to it. Use diagonal cutters to cut off one side of each stud holding the strip. This frees the strip, and the remainder of the stud can then be pulled free of the chassis with a pair of pliers. The spacers may come out with the studs; if not, they can be pulled out separately. If they are not damaged, the spacers may be used with the new strip assembly. Ceramic strips are supplied with studs attached, so it is not necessary to salvage the old studs.

After removing a damaged strip and stud assembly, place the spacers into the holes in the chassis and insert the studs into the spacers. Be sure that the studs are completely seated in the spacers. If necessary, use a soft-faced mallet to tap the studs into the spacers. Tap the studs in equal increments to prevent strains on the ceramic strip.

## Troubleshooting Techniques

If the instrument is not operating, first check that the power cord is plugged in and that there is power at the socket. Then check that the pilot lamp and tube heaters are lit. If necessary, check the line fuse.

Attempt to isolate the trouble by a quick operational and visual check. Make sure that any apparent trouble is actually due to a malfunction within the instrument and not to improper control settings or to a faulty plug-in unit or probe. Instructions for the operation of the Type 546 and general information concerning plug-in operation are contained in Section 2. Operating instructions for a specific plug-in unit or probe will be found in the manual for that unit.

Check the settings of all controls on the Type 546 and the vertical plug-in preamplifier unit. A control set to the wrong position may cause what appears to be a trouble symptom. Operate the controls to see what effect, if any, they have on the trouble symptom. The normal or abnormal operation of each particular control helps in establishing the nature of the trouble.

When vertical-system troubles are encountered, isolate the trouble to the Type 546 or to the vertical plug-in preamplifier unit. The best way to determine this is by substituting another vertical plug-in preamplifier unit. If the trouble appears to be in the plug-in unit, refer to the Maintenance section of the plug-in unit instruction manual.

If other plug-in units are not available, and the symptoms are not definite, check the power-supply resistances and voltages since a failure in one of the regulated power supplies frequently presents unusual symptoms. Table 5-2 in the Calibration Procedure lists normal resistance to ground for each power-supply lead. Typical voltages in the power supplies are shown on the power-supply schematic. The voltages shown may vary slightly from instrument to instrument.

All wiring used in the Type 546 is color coded to facilitate circuit tracing. In addition, all regulated power-supply leads are coded with specific color combinations for easy identification. In general, three strips are placed on the wires of the regulated supplies. The code used is the standard EIA number-color code. The first color (widest stripe) indicates the first number of the voltage on that lead. The second color indicates the second number of the lead voltage, and the third color is a multiplier. The method is similar to that used in color coding resistors. Thus, the +100-volt leads are coded brown, black, brown. The voltage is positive if the body color of the wire is white and negative if the body color of the wire is tan.

Reference voltage for the regulated supplies is obtained from the —150-volt supply. If it is not operating properly, the other low-voltage supplies will be affected. For this reason, the —150-volt supply should be checked first when trouble is suspected in the low-voltage supplies. If the output of the —150-volt supply is correct, then check the outputs of the other supplies.

Most troubles that might occur in Tektronix instruments result from the failure of vacuum tubes or semiconductors. Once the trouble has been isolated to a particular area or circuit, check the tubes and semiconductors in the trouble area. It is preferable to check them by substitution rather than with a tester, since testers frequently fail to indicate certain troubles which can affect oscilloscope performance. Remember that when a tube or semiconductor fails, associated circuit components can be damaged.

## Circuit Troubleshooting

The Type 546 consists of nine main circuits plus the Calibrator and Alternate-Trace Sync Amplifier circuits. The 9 main circuits are:

1. Low-Voltage Power Supply
2. Crt Circuit (including the High-Voltage Power Supply)
3. Vertical Amplifier and Delay Line
4. Main Time Base (B) Sweep-Trigger Circuit
5. Main Time Base (B) Sweep Generator
6. Time Base A Sweep Trigger Circuit
7. Time Base A Sweep Generator
8. Delay-Pickoff Circuit
9. Horizontal Amplifier

The crt display can often be used to identify a defective circuit. For example, if there is no vertical deflection when the intensity and horizontal deflection appears normal, the trouble can be open signal connections, no signal source, the plug-in unit or even loose crt connections. Other abnormal characteristics in the crt display similarly point to a defective circuit or group of circuits.

Once the nature and approximate location of the trouble has been determined, further isolate the trouble by performing the steps in the calibration procedure for the circuits in which trouble is suspected. The voltages and waveforms to be expected in each circuit are shown on the schematics. Refer to Section 3 for an explanation of the operation of the defective circuit.

IMPORTANT

When it is desired to operate the plug-in unit from a plug-in extension, the plug-in sensing switch (SW673, located at the top rear of the plug-in compartment) must be manually operated. To manually operate the switch, pull the plastic plunger outward to the stop position.

## NOTES

# SECTION 5

# CALIBRATION

## Introduction

The Type 546 Oscilloscope is a stable instrument which will provide many hours of trouble-free operation. However, to insure measurement accuracy, it is suggested that you recalibrate the instrument after each 500 hours of operation or every six months if used intermittently. It will also be necessary to recalibrate certain sections of the instrument when tubes, transistors, or other components are replaced.

The steps in the following procedure are arranged in the proper order for complete recalibration so as to avoid unnecessary repetition.

NOTE

**This procedure is a combination performance check and adjustment procedure. The first part of the step title is the name of the check or adjustment and the latter portion refers to the pertinent circuit diagram. Tables 5-4, 5-5, 5-6, 5-8 , 5-10, and 5-11 list the front-panel control settings at particular points in the procedure. These tables serve two purposes: (1) To quickly check your own setup, and (2) to enable you to start in the "middle" of the procedure when it is necessary to recalibrate a certain portion of the instrument. For example, Table 5-4 shows the front-panel setup at the completion of step 12e. Using these same control settings this can be the starting point for recalibrating the A Sweep Trigger circuit. Table 5-4 can also be used when determining the setup needed for starting the recalibration of the B Sweep Trigger circuit. There is no need to go back any further towards the beginning of the procedure to find out what the front-panel setup should be.**

**Unless otherwise stated, all resistances, voltages, and waveforms are measured with respect to chassis ground.**

## EQUIPMENT REQUIRED

The following equipment or its equivalent, is necessary for complete calibration of the Type 546 Oscilloscope:

(1) Low-Bandwidth Test Oscilloscope with a 1X attenuator probe.
Description: Bandwidth, dc to 300 kc or better; calibrated vertical deflection factor of 5 mv/cm.
Purpose: To check low-voltage power supply output ripple amplitude.

(2) Test load unit, Tektronix Type TU-7. Contains a pulse generator capable of producing pulses with a risetime of 3 nsec or faster. This multi-purpose test-load unit is the only plug-in needed to perform a complete calibration of the Type 546 Oscilloscope.

(3) Time Mark generator, Tektronix Type 180A. Markers required at 1 and 5 seconds; 500, 100, 10, 5, and 1 milliseconds; 500, 100, 50, 10, 5 and 1 microseconds; 5, 10 and 50 megacycle sine waves. 10 $\mu$sec trigger pulse output required. All outputs must have a time accuracy of at least 0.1%.

(4) VOM (Volt-Ohm-Milliammeter) DC sensitivity of at least 20,000 ohms per volt.
Calibrated for an accuracy of at least 1% at —150, +100, +225, and +350 volts; at least 5% at —1850 volts.

(5) Variable autotransformer (e.g. Powerstat or Variac). Required specifications: a rating of at least 600 volt-amperes; output voltage range covering the operating range of the oscilloscope under test.

(6) An rms-calibrated ac voltmeter. Required specifications: a range of 0-150 volts (0-300 volts if the oscilloscope is wired for 230-volt nominal line-voltage operation.

(7) Two coaxial cables, 50-ohm nominal impedance, 42" long, with BNC plug-connectors on each end. Part No. 012-057.

(8) Power cord adapter for connecting the 3-wire oscilloscope power cord to a 2-wire receptacle. Part No. 103-013.

(9) Adapter, single binding post fitted with a BNC plug. Part No 103-033.

(10) Coaxial connector adapter with BNC-jack and UHF-plug connector fittings. Part No. 103-015.

(11) Jumper clip lead, about 4" long. Equipped with miniature alligator clips on each end.

(12) Two interconnecting leads, 18" long, red, with combination plug-and-jack banana type connectors on each end. Type PC-18R. Part No. 012-031.

(13) BNC T connector. Fits one BNC jack and accepts two BNC plugs. Part No. 103-032.

(14) Miscellaneous Items

1—Screwdriver, 3/16" wide bit, shank about 3" long.

1—Screwdriver, 3/32" wide bit, shank about 2" long.

1—Jaco No. 125 insulated low-capacitance-type screwdriver with a 1 1/2" long shank and 1/8" wide metal tip. Total length is 5". Part No. 003-000.

1—Low-capacitance alignment tools, consisting of a handle (Part No. 003-307), a gray nylon insert with a metal screwdriver tip (Part No. 003-334), a 5/64" hexagonal wrench insert (Part No. 003-310).

1—Hexagonal wrench, 1/16". Purpose: To reposition, if necessary, the TRIGGERING LEVEL control knobs.

## PRELIMINARY PROCEDURE

1. Remove the cabinet from the oscilloscope.
2. Insert the Type TU-7 (item 2) in the oscilloscope vertical plug-in compartment.

3. Set the Type TU-7 Test Function switch to the Low Load position.

4. Lay the oscilloscope on its right side for access to the bottom of the instrument, (and later in the procedure for access to the —150 VOLTS control.

5. Using the VOM, check the resistance at the regulated bus of each power-supply lead to ground at the test points shown in Fig. 5-1. The values of resistances should be approximately as indicated in Table 5-1, once the capacitors are charged by the VOM internal battery.

TABLE 5-1

| POWER SUPPLY LEAD | RESISTANCE TO GROUND |
|---|---|
| —150 volts | 1 k to 2 k |
| +100 volts | 1 k to 2 k |
| +225 volts | 2 k to 3 k |
| +350 volts | Over 40 k |

6. Check the fuse at the rear of the instrument for correct value.

7. Connect the instrument and ac voltmeter to the autotransformer output. Connect the autotransformer to the power line.

8. Turn the INTENSITY control on the instrument fully counterclockwise and turn on the power to all the equipment. Adjust the autotransformer output voltage to 115 volts (or the design-center voltage for which the instrument is wired).

9. Set the oscilloscope front-panel controls to the positions listed in Table 5-2.

TABLE 5-2

| | |
|---|---|
| CRT Controls | |
| INTENSITY | 0 |
| FOCUS | As is |
| ASTIGMATISM | As is |
| SCALE ILLUM | 5 |
| Time Base A | |
| TRIGGERING LEVEL | ccw; knob pushed in |
| TRIGGERING— | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | NORM INT |
| VARIABLE (TIME/CM) | CALIBRATED |
| TIME/CM | .5 mSEC |
| Horizontal Display | |
| HORIZONTAL DISPLAY | A |
| SWEEP MAGNIFIER | X1 OFF |
| SINGLE SWEEP SWITCH | NORMAL |
| Main Time Base (B) | |
| TRIGGERING LEVEL | ccw; knob pushed in |
| TRIGGERING— | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | NORM INT |
| VARIABLE (TIME/CM) | CALIBRATED |
| TIME/CM | .5 mSEC |
| BRIGHTNESS | Fully clockwise |
| Other Controls | |
| DELAY-TIME MULTIPLIER | 1.00 |
| HORIZONTAL POSITION | Midrange |
| VERNIER (HORIZONTAL POSITION) | Midrange |
| AMPLITUDE CALIBRATOR | OFF |

10. Set the Type TU-7 front-panel controls to these settings:

| | |
|---|---|
| Vertical Position | Centered |
| Test Function | Low Load |
| Other Controls | As is |

11. Allow about five minutes warm-up time. Check that the EXT CRT CATHODE-to-GND shorting strap is in place on the terminals and the CRT CATHODE SELECTOR switch is at EXTERNAL CRT CATHODE position.

12. Recheck the autotransformer output for proper design center voltage as soon as the instrument is warmed up.

## CALIBRATION PROCEDURE

### 1. Check Voltage Accuracy—Power Supply

(If necessary, adjust —150 VOLTS R616)

a. Establish the conditions given in the Preliminary Procedure.

b. Check that the oscilloscope is placed on its right side for access to the bottom and left side of the instrument.

c. Check the voltage accuracy of each power supply output using the VOM (item 4) according to the information given in Table 5-3. The location of the test points is shown in Fig. 5-1.

TABLE 5-3

| Power Supply | Tolerance | Maximum Peak-to-Peak Ripple |
|---|---|---|
| —150 v | —147 to —153 | 10 mv |
| +100 v | +98 to +102 | 15 mv |
| +225 v | +220.5 to +229.5 | 10 mv |
| +350 v | +343 to +357 | 25 mv |

d. If necessary, adjust to —150 VOLTS R616 control (see Fig. 5-2) so all power supply voltages are within tolerance.

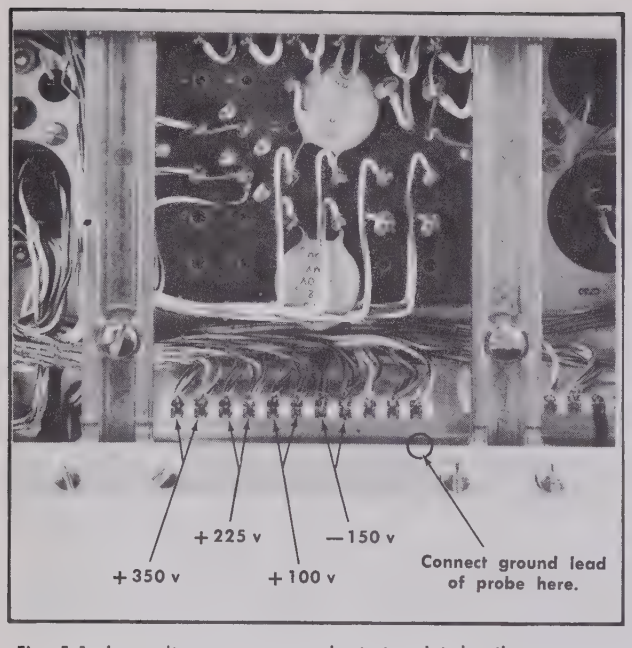



Fig. 5-1. Low-voltage power supply test point locations.

NOTE

Don't adjust the —150 VOLTS control unless one or more of the supplies is actually out of tolerance. Remember that the calibration of the entire instrument is affected by changes in the power supply voltages. All the positive voltage power supplies depend upon the —150-volt supply measurement accuracy.

**2. Check Regulation and Output Ripple— Power Supply**

NOTE

When checking for proper regulation of the power supplies at the lower line voltage limit, the ac line voltage should contain no more than 3% distortion.

a. Monitor the regulated output of the —150-volt supply with the VOM. The test point location is shown in Fig. 5-1.

b. Connect a 1X probe from a test oscilloscope (item 1) to the —150-volt test point and check the output ripple amplitude. The maximum ripple voltage is given in Table 5-3.

NOTE

Ground loops can cause an erroneous ripple measurement. (Ripple due to ground loops is the same frequency as the line; low-voltage power supply ripple is twice the line rate.) One way to avoid ripple due to ground loops is to temporarily disconnect the chassis ground wire in the power cord by using an ungrounded 3- to 2-wire line plug adapter. Then use a ground lead from the signal probe body to make a ground connection to the oscilloscope chassis at the location shown in Fig. 5-1. The probe will then provide the only ground connection between the two instruments. The term "test oscilloscope" is item 1 while the term "oscilloscope" or "instrument" is the oscilloscope being calibrated.

c. Slowly increase the output of the variable autotransformer to 126.5 vac (or 10% above the design-center line voltage for which the instrument is wired). The dc output voltage should remain essentially constant; typically within 2% of that obtained with design-center line voltage. The ripple voltage should not exceed the maximum peak-to-peak amplitude given in Table 5-3.

d. Repeat steps 2a through 2c for each supply.

e. Reset the autotransformer for 115 volts output (or design-center voltage for which the instrument is wired).

f. Set the Type TU-7 Test Function Load switch to High Load.

g. Reduce the line voltage to 103.5 volts (or 10% below design-center voltage). The dc output voltage of each supply should remain essentially constant; typically within 2% of that obtained at design-center voltage. Ripple voltage should not exceed the maximum peak-to-peak amplitude given in Table 5-3.

h. Disconnect the VOM and X1 Probe.

i. Reset the autotransformer for 115 volts output (or design-center).

j. Set the Type TU-7 Test Function switch to Low Load.

k. If the 3-to-2 line-plug adapter was used during this step, turn off the oscilloscope power and remove the adapter. Plug the line cord directly into the autotransformer and turn on the oscilloscope power.

**3. Adjust HIGH VOLTAGE R840—Crt Circuit**

a. Set the scale of the VOM to measure —1850 volts and connect the VOM between the high-voltage test point (see Fig. 5-3) and ground.

b. Adjust the HIGH VOLTAGE control R840 (see Fig. 5-2) for a —1850 volt meter indication.

**4. Check High Voltage Regulation—Crt Circuit**

a. With the VOM connected to the high voltage test point, use the meter to monitor the voltage at this point.

b. Set the A TRIGGERING MODE switch to AUTO.

c. Rotate the INTENSITY control clockwise until the trace is at normal intensity. Use the Type TU-7 Vertical Position control to vertically center the trace. Defocus the trace with the FOCUS and ASTIGMATISM control. Set the INTENSITY control at 7.

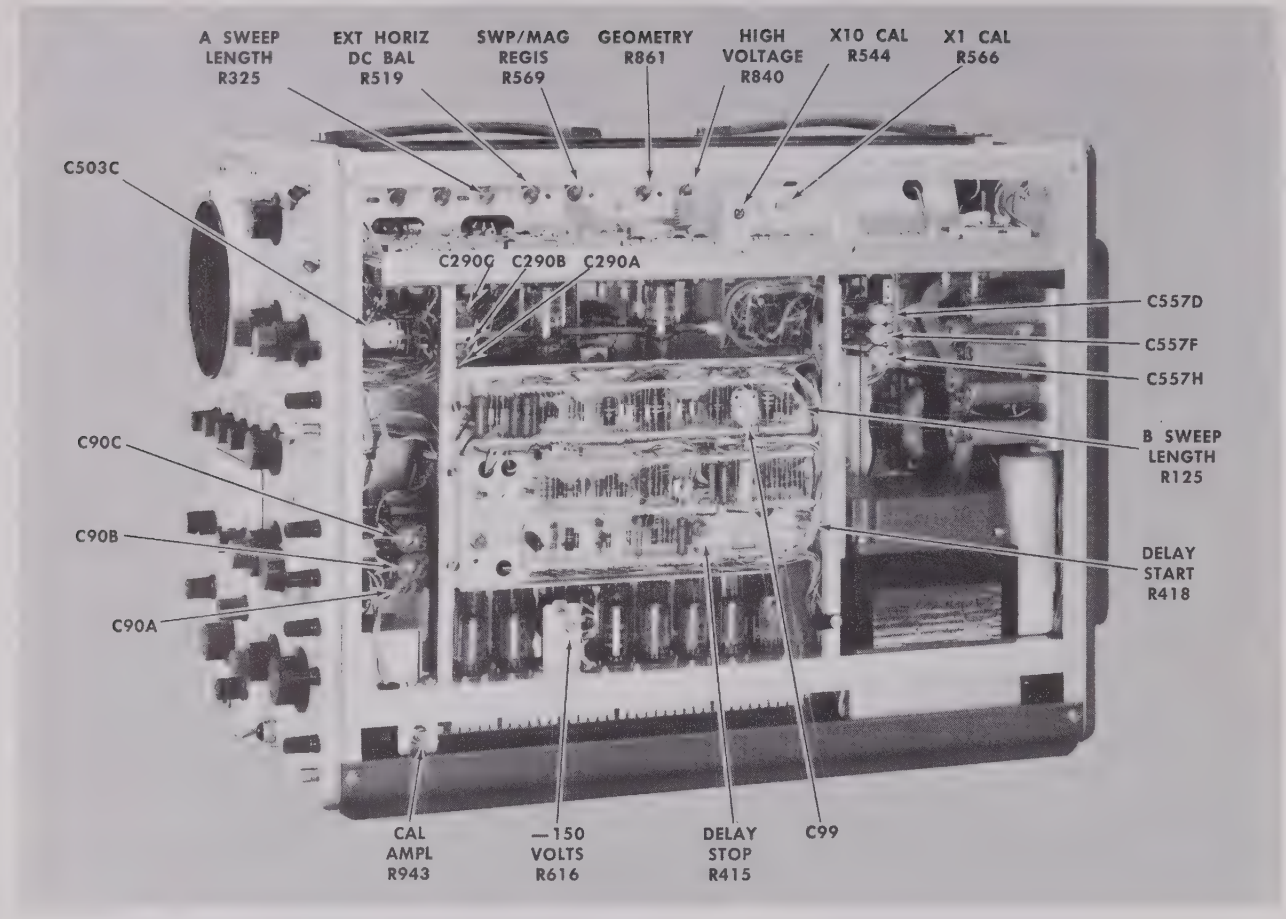



Fig. 5-2. Calibration adjustment location.

d. Use the HORIZONTAL POSITION control to position the trace to start at the left side of the graticule.

e. Slowly increase the output of the variable autotransformer to 126.5 vac (or 10% above the design-center line-voltage for which the instrument is wired). The high voltage dc output should remain essentially constant; typically within 2% of that obtained with design-center line voltage. The trace should not show any signs of blooming. (Blooming is when the display changes size as the supply voltage changes.)

f. Reset the autotransformer for 115 volts output (or design-center voltage for which the instrument is wired).

g. Set the Type TU-7 Test Function switch to High Load.

h. Reduce the line voltage to 103.5 volts (or 10% below design-center voltage). The high voltage dc output should remain constant; typically within 2% of that obtained with design-center line voltage. The trace should not show any signs of blooming.

i. Reset the autotransformer for 115 volts output (or design-center).

j. Set the Type TU-7 Test Function switch to Low Load.

k. Decrease the trace intensity to normal with the INTENSITY control.

l. Disconnect the VOM.

### 5. Adjust CAL AMPL (Calibrator Amplitude)—R943—Calibrator

a. Connect a single binding post adapter (item 9) to the oscilloscope CAL OUT connector.

b. Connect the VOM to the binding post adapter and to the oscilloscope chassis.

c. Set the AMPLITUDE CALIBRATOR switch to 100 V DC.

d. Adjust the CAL AMPL control R943 (see Fig. 5-2) for a voltmeter reading of exactly 100 volts.

### 6. Check Duty Factor of Signal—Calibrator

a. Set the AMUPLITUDE CALIBRATOR switch to 100 VOLTS (not 100 V DC).

b. Check for a voltmeter reading of +45 to +55 volts as measured between the CAL OUT connector and ground.

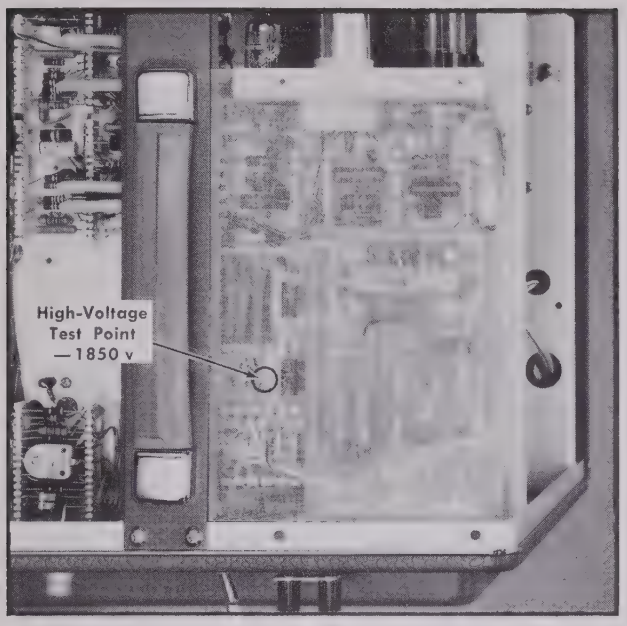



Fig. 5-3. High-voltage test point location.

NOTE

+50 volts indicates a nominal duty factor of 0.5. If the voltage is not within +45 to +55 volts try new tubes.

c. Disconnect the VOM and set the AMPLITUDE CALIBRATOR switch to OFF.

d. Remove the adapter from the CAL OUT connector.

**7. Adjust TRACE ROTATION—Crt Circuit**

a. Adjust the FOCUS and ASTIGMATISM controls for narrowest trace.

b. Position the trace directly behind the center horizontal graticule line, using the Type TU-7 Vertical Position control.

c. If the trace and graticule line do not coincide over the width of the graticule, adjust the TRACE ROTATION control for correct trace alignment.

**8. Adjust GEOMETRY R861—Crt Circuit**

a. Apply 50 μsec markers from the time-mark generator through a coaxial cable to the Type TU-7 Ext Input connector.

b. Set the A TIME/CM switch to 50 μSEC.

c. Advance the INTENSITY control to make the display visible.

d. Set the TRIGGERING LEVEL control to obtain a stable display of vertical marker lines.

e. Adjust the TU-7 Variable control so the markers overscan the crt; set the Vertical Position control to position the base line of the markers below the display area.

f. Use the HORIZONTAL POSITION control to position the markers so they align with the graticule markings.

g. Adjust the GEOMETRY control R861 (see Fig. 5-2) for straightest possible vertical marker-lines running parallel to the 0-cm and 10-cm graticule. Note the amount of bowing.

h. Disconnect the signal from the TU-7 Ext Input connector.

i. Reduce the trace intensity to normal with the INTENSITY control while positioning the trace onto the crt with the TU-7 Vertical Position control.

j. Using the TU-7 Vertical Position control, position the trace to the bottom of the graticule. Note the amount of bowing. Then position the trace to the top of the graticule and note the amount of bowing.

k. Repeat steps 8a through 8j so the trace exhibits minimum bowing in both planes.

l. After completing the previous steps, disconnect the signal from the TU-7 Ext Input connector. Check that the trace is positioned into the display area and the INTENSITY control is set to a suitable trace brightness level.

**9. Adjust VERT DC BAL (Vertical Amplifier Dc Balance) R1004—Vertical Amplifier**

a. Using a small screwdriver, short the crt vertical deflection plate pins together (see Fig. 5-4).

CAUTION

Do not short the crt deflection plate pins to ground.

b. Note the position of the trace. This is the electrical center of the crt vertical deflection plates.

c. Remove the screwdriver from the crt pins.

d. Short the cases of Q1074 and Q1084 together (see Fig. 5-4) and note the trace deviation from electrical center. Deviation should not be more than 0.5 cm maximum. Remove the short.

e. Short the collector of Q1034 to the collector of Q1044 (see Fig. 5-4) and note the trace deviation from electrical center. Deviation should not be more than 0.5 cm maximum. Remove the short.

f. Short the cases of Q1014 and Q1024 together (see Fig. 5-4) and note the trace deviation from electrical center. Deviation should not be more than 0.5 cm maximum. Remove the short.

g. Set the Type TU-7 Test Function switch to Common Mode.

h. Adjust the VERT DC CAL control R1004 (see Fig. 5-4) to position the trace to the center of the graticule.

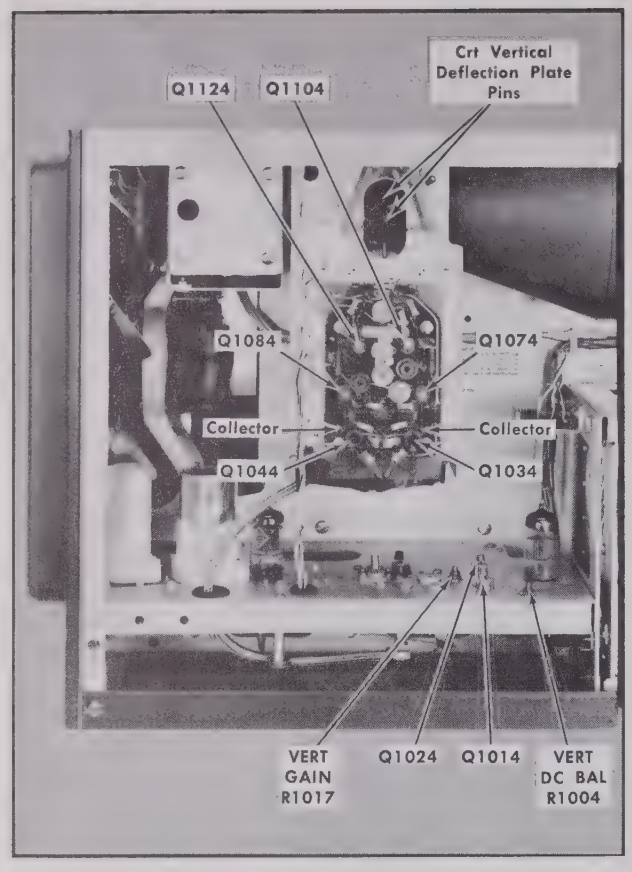



**Fig. 5-4. Vertical Amplifier test point and adjustment locations for performing steps 9 and 10.**

### 10. Adjust VERT GAIN (Vertical Amplifier Gain) R1017—Vertical Amplifier

a. Set the Type TU-7 Test Function switch to the Gain Set position.

b. Connect a coaxial cable between the Type TU-7 Ext Input connector and the oscilloscope CAL OUT connector.

c. Set the AMPLITUDE CALIBRATOR switch to 100 VOLTS.

d. Pull the 'A' TRIGGERING LEVEL control outward for X10 range increase and rotate the control fully clockwise to free run the time base.

e. Adjust the VERT GAIN control R1017 (see Fig. 5-4) so the display vertical deflection is exactly four centimeters in amplitude.

### 11. Check Common-Mode Rejection—Vertical Amplifier

a. Set the AMPLITUDE CALIBRATOR switch to 1 VOLT.

b. Set the TU-7 Test Function switch to Common Mode.

c. Set the A TIME/CM switch to .5 mSEC.

d. Note the amplitude of the calibrator waveform. The amplitude of the waveform should not be more than 3 mm maximum.

### 12A. Adjust A TRIGGER LEVEL CENTERING R225 and A TRIGGER SENS R245—A Sweep Trigger (SN 963-up) [FOR RM546 (SN 500-up)]

a. Set the AMPLITUDE CALIBRATOR to .1 volts.

NOTE

A 100 mv peak-to-peak signal is used in this portion of the procedure as an adjustment aid only and is not intended to be interpreted as a trigger-amplitude specification that contradicts the one given in the Characteristics section of this manual.

b. Insert a BNC T connector between the CAL OUT connector and the coax cable to the TU-7 Ext Input. Connect another coax cable from the T connector to the A TRIGGER INPUT connector. (The CAL OUT connector should not be connected to the Ext Input connector on the TU-7 and to the A TRIGGER INPUT connector on the oscilloscope.)

c. Set the front-panel controls as follows:

**Type 546/RM546**

Controls not mentioned may be left as is

| | |
|---|---|
| INTENSITY | As required for a visible trace |
| FOCUS | As required for a focused trace |
| ASTIGMATISM | As required for a focused trace |
| SCALE ILLUM | As required for a visible graticule |
| HORIZONTAL POSITION | As required to position trace to the left edge of the graticule |
| VERNIER (HORIZONTAL POSITION) | Midrange |
| HORIZONTAL DISPLAY | A |
| SWEEP MAGNIFIER | X1 (OFF) |
| SINGLE SWEEP Switch | Normal |

**Time Base A**

| | |
|---|---|
| TRIGGERING LEVEL | 0 |
| TIME/CM | .5 mSEC |
| TRIGGERING | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | EXT |

**TU-7**

| | |
|---|---|
| Variable | Fully Clockwise |
| Position | Centered |
| Test Function | Low Load |

**Test Oscilloscope**

| | |
|---|---|
| Input Coupling | AC |
| Volts/Div | .02 |
| Time/Div | .5 mSEC |
| Triggering | |
| Mode | AUTO |
| Slope | + |
| Coupling | AC |
| Source | Internal |

d. Locate the junction of R217, C218, R218, (See Fig. 5-5a). Connect a short jumper clip lead between the junction and ground. This jumper disables the A TRIGGERING LEVEL control.

e. Locate the junction of R252 and L250 (See Fig. 5-5a). Connect a 10× probe from the test oscilloscope to this junction.

f. Preset the A TRIGGER LEVEL CENTERING R225 control to midrange and the A TRIG SENS R245 control fully clockwise.

g. Adjust the A TRIGGER LEVEL CENTERING R225 control for a stable display of square waves on the test oscilloscope (the square waves will have an amplitude of approximately 200 mv peak-to-peak). Note that there is a range in the adjustment of R225 through which the square wave display will remain stable. Set R225 approximately in the middle of this range.

h. Change the SLOPE switch to — and readjust R225 if necessary. Continue alternating the position of the SLOPE switch and adjusting R225 until the square wave on the test scope is stable in both positions of the SLOPE switch.

i. Turn the A TRIGGER SENS R245 control counterclockwise until the square wave on the test oscilloscope just begins to break up. (This will occur where the square wave suddenly reduces in amplitude.) Leave R245 set at this point.

j. Readjust the A TRIGGER LEVEL CENTERING R225 control for a stable square wave display at both postions of the SLOPE switch. (Note that there is a range in the adjustment of R225 over which a stable square wave can be obtained. Set R225 in the center of this range.)

k. Set the AMPLITUDE CALIBRATOR switch to 50 mVOLTS. The amplitude of the square wave display on the test oscilloscope should be reduced to less than 100 millivolts in either position of the SLOPE switch. If the amplitude of the square wave on the test oscilloscope remains at approximately 200 millivolts, repeat i through k.

l. Disconnect the 10× probe from the junction of R252 and L250.

**12B. Adjust A TRIGGER LEVEL CENTERING R225 and A TRIGGER SENS R245—A Sweep Trigger (SN 101-962) [RM546 (SN 101-499)]**

a. Set the AMPLITUDE CALIBRATOR switch to 50 mvolts.

b. Insert the BNC T connector between the AMPLITUDE CALIBRATOR connector and the coaxial cable.

c. Connect another coaxial from the T connector to the A TRIGGER INPUT connector. (The CAL OUT connector should now be connected to the Ext Input connector on the Type TU-7 and to the A TRIGGER INPUT connector on the oscilloscope.)

d. Set the TU-7 front-panel controls as follows:

| | |
|---|---|
| VARIABLE | Fully clockwise |
| POSITION | Centered |
| TEST FUNCTION | Low Load |

e. Set the A MODE switch to TRIG and the A TRIGGERING LEVEL control to 0. Check that the A COUPLING switch is set at AC and the A SOURCE switch is set to EXT.

f. Locate the junction of R217, C218, and R218. Connect the short jumper clip lead between the junction and ground. This jumper disables into A TRIGGERING LEVEL control.

g. Connect a 10X Probe from the test osscilloscope the junction of R245-R248.

h. Set the test oscilloscope controls as follows:

| | |
|---|---|
| INPUT COUPLING | AC |
| VOLTS/DIV | .02 |
| TIME/DIV | .2 mSEC |
| TRIGGERING | |
| MODE | AUTOMATIC |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | INTERNAL |

i. Set the TRIGGER SENS R245 to midrange.

j. Rotate TRIGGER LEVEL CENTERING R225 fully counterclockwise.

k. Rotate TRIGGER LEVEL CENTERING R225 clockwise until a stable display 2 to 3 major divisions high appears on the test oscilloscope.

l. If no stable display appears on the test oscilloscope, rotate the TRIGGER SENS R245 slightly clockwise, then repeat part k.

m. Change the Triggering SLOPE switch to — and check for a stable display on the test oscilloscope. If necessary readjust the TRIGGER LEVEL CENTERING R225 slightly so as to obtain a stable test oscilloscope in both positions of the A SLOPE switch.

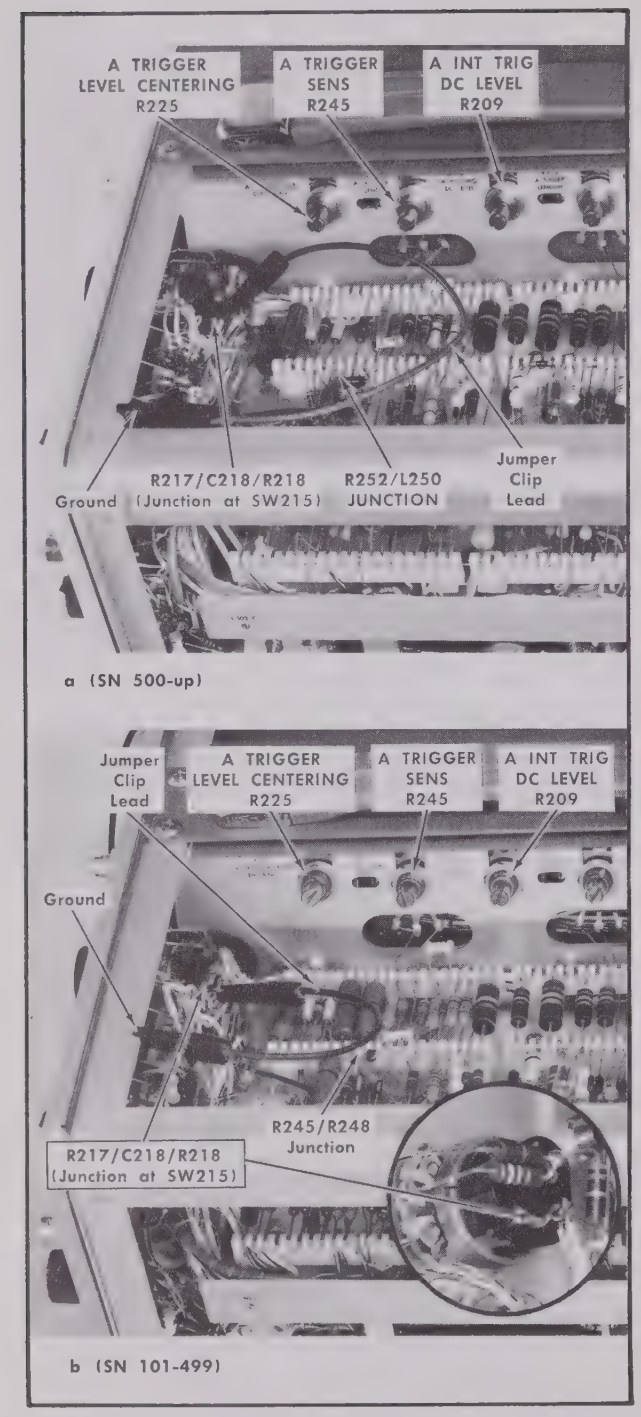



**Fig. 5-5. A Trigger clip-lead connection, adjustment and test point locations.**

n. If a stable test oscilloscope display can not be obtained for both A SLOPE switch positions, rotate the TRIGGER SENS R245 slightly clockwise and repeat part m.

o. After obtaining a stable test oscilloscope display for both A SLOPE switch positions, rotate the TRIGGER SENS R245 slightly counterclockwise. Again check for a stable test oscilloscope display in both positions of A SLOPE switch. TRIGGER LEVEL CENTERING R225 may have to be readjusted slightly.

p. Continue rotating the TRIGGER SENS R245 slightly counterclockwise and then checking the test oscilloscope display until a stable test oscilloscope display can not be obtained for both positions of the Triggering SLOPE switch.

q. Rotate the TRIGGER SENS R245 just enough clockwise to permit a stable test oscilloscope display to be obtained for both positions of the Triggering SLOPE switch. Slight readjustment of TRIGGER LEVEL CENTERING R225 will probably be necessary.

**13. Adjust A INT TRIG DC LEVEL (A Internal Trigger DC Level) R209—A Sweep Trigger**

a. Set the AMPLITUDE CALIBRATOR switch to .5 VOLTS.

b. Set the A SOURCE switch to NORM INT.

c. Adjust the TU-7 Variable control so the displayed waveform is 5 mm peak-to-peak in amplitude.

d. Using the TU-7 Vertical Position control, center the display for equal amplitude above and below the center graticule line.

e. Set the A COUPLING switch to DC.

f. Adjust the A INT TRIG DC LEVEL R209 control (see Fig. 5-5) to obtain a stable display. (With the 'A' SLOPE switch set to +, the sweep trace should start on the positive-going rise of the calibrator waveform.)

**14. Check Internal Triggering—A Sweep Trigger**

a. Set the A COUPLING switch to AC.

b. Adjust the TU-7 Variable control until the display is 2 mm peak-to-peak in amplitude.

c. Disconnect the jumper clip lead.

d. Adjust the A TRIGGERING LEVEL control to obtain a stable display.

e. Operate the A SLOPE switch. Check for stable time-base triggering on the —slope when the SLOPE switch is set to — and stable triggering on the +slope when the SLOPE switch is set to +. If necessary, readjust the A TRIGGERING LEVEL control to obtain a stable display when making the check for each SLOPE switch position.

**15. Check A TRIGGERING LEVEL Control Zero Set—A Sweep Trigger**

a. Check that the A TRIGGERING LEVEL control is set to 0 and the SLOPE switch is set to +.

b. Connect the VOM between the R217/C218/R218 junction and ground.

c. Carefully rotate the A TRIGGERING LEVEL control to obtain a reading of exactly zero volts on the VOM.

d. If the A TRIGGERING LEVEL knob is set properly on the control shaft, the white dot on the knob should be directly below the 0 on the front panel. If the white dot does not point accurately to 0, disconnect the VOM, loosen the setscrew in the knob and reposition the knob.

e. After tightening the knob, set the knob to 0, reconnect the VOM, and recheck the reading. The VOM reading should be zero when the A TRIGGERING LEVEL knob is set to 0.

NOTE

**A dc-coupled test oscilloscope with a 10X probe can be used in place of the VOM to perform this step, if desired. As another method, the white dot on the A TRIGGERING LEVEL knob should point to 0 to obtain stable triggering when operating the A SLOPE switch as directed in step 14.**

f. Disconnect the VOM or 10X probe, whichever one is used.

**16A. Adjust B TRIGGER LEVEL CENTERING R25 and B TRIGGER SENS R45—B Sweep Trigger (SN 963-up) [FOR RM546 (SN 500-up)]**

a. Set the AMPLITUDE CALIBRATOR to .1 volts.

NOTE

**A 100 mv peak-to-peak signal is used in this portion of the procedure as an adjustment aid only and is not intended to be interpreted as a trigger-amplitude specification that contradicts the one given in the Characteristics section of this manual.**

b. Insert a BNC T connector between the CAL OUT connector and the coax cable to the TU-7 Ext Input. Connect another coax cable from the T connector to the B TRIGGER INPUT connector. (The CAL OUT connector should now be connected to the Ext Input connector on the TU-7 and to the B TRIGGER INPUT connector on the oscilloscope.)

c. Set the front-panel controls as follows:

**Type 546/RM546**

Controls not mentioned may be left as is

| | |
|---|---|
| HORIZONTAL DISPLAY | B |
| BRIGHTNESS | As required for visible trace |

**Time Base B**

| | |
|---|---|
| TRIGGERING LEVEL | 0 |
| TIME/CM | .5 mSEC |
| TRIGGERING | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | EXT |

**TU-7**

| | |
|---|---|
| Variable | Fully Clockwise |
| Position | Centered |
| Test Function | Low Load |

**Test Oscilloscope**

| | |
|---|---|
| Input Coupling | AC |
| Volts/Div | .02 |
| Time/Div | .5 mSEC |
| Triggering | |
| Mode | AUTO |
| Slope | + |
| Coupling | AC |
| Source | Internal |

d. Locate the junction of R17, C18, R18 (See Fig. 5-6a). Connect a short jumper clip lead between the junction and ground. This jumper disables the B TRIGGERING LEVEL control.

e. Locate the junction of R52 and L50 (See Fig. 5-6a). Connect a 10× probe from the test oscilloscope to this junction.

f. Preset the B TRIGGER LEVEL CENTERING R25 control to midrange and the B TRIG SENS R45 fully clockwise.

g. Adjust the B TRIGGER LEVEL CENTERING R25 control for a stable display of square waves on the test oscilloscope. (The square waves will have an amplitude of approximately 200 mv peak-to-peak.) Note that there is a range in the adjustment of R25 through which the square wave will remain stable. Set R25 approximately in the middle of this range.

h. Change the SLOPE switch to — and readjust R25 if necessary. Continue alternating the position of the SLOPE switch and adjusting R25 until the square wave display on the test oscilloscope is stable in both positions of the SLOPE switch.

i. Turn the B TRIGGER SENS R45 control counterclockwise until the square wave display on the test oscilloscope just begins to break up. (This will occur where the square wave suddenly reduces in amplitude.) Leave R45 set at this point.

j. Readjust the B TRIGGER LEVEL CENTERING R25 control for a stable square wave display at both positions of the SLOPE switch. (Note that there is a range in the adjustment of the R25 over which a stable square wave can be obtained. Set R25 in the center of this range.)

k. Set the AMPLITUDE CALIBRATOR to 50 mVOLTS. The amplitude of the square wave display on the test oscilloscope should be reduced to less than 100 millivolts in either position of the SLOPE switch. If the amplitude of the square wave display on the test oscilloscope remains at approximately 200 millivolts, repeat steps i through k.

l. Disconnect the 10× probe from the junction of R52 and L50.

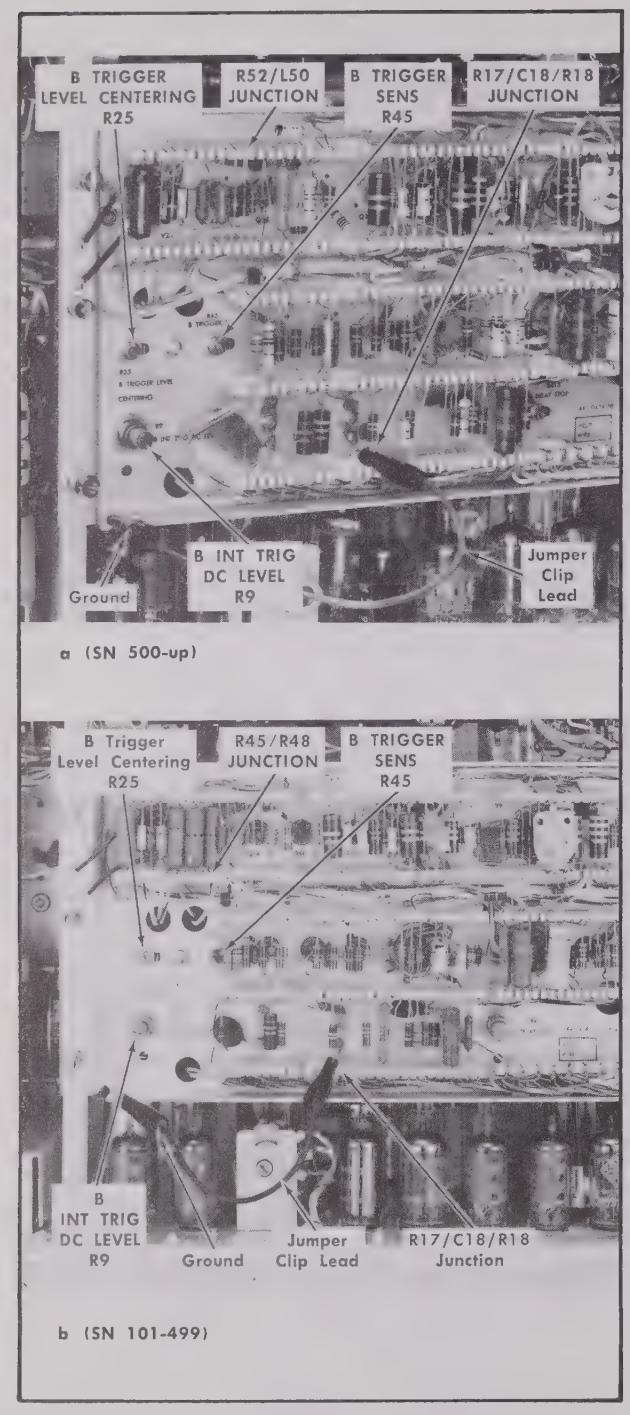



Fig. 5-6. B Trigger clip-lead connections, adjustment and test point locations.

### 16B. Adjust B TRIGGER LEVEL CENTERING R25 and B TRIGGER SENS R45—B Sweep Trigger (SN 101-962) [RM546 (SN 101-499)]

a. Set the AMPLITUDE CALIBRATOR switch to 50 mvolts.

b. Insert the BNC T connector between the AMPLITUDE CALIBRATOR connector and the coaxial cable.

c. Connect another coaxial cable from the T connector to the B TRIGGER INPUT connector. (The CAL OUT connector should now be connected to the Ext Input connector on the Type TU-7 and to the B TRIGGER INPUT connector on the oscilloscope.)

d. Set the TU 7 front-panel controls as follows:

| | |
|---|---|
| VARIABLE | Fully clockwise |
| POSITION | Centered |
| TEST FUNCTION | Low Load |

e. Set the B MODE switch to TRIG and the B TRIGGERING LEVEL control to 0. Check that the B COUPLING switch is set at AC and the B SOURCE switch is set to EXT.

f. Locate the junction of R17, C18, and R18. Connect the short jumper clip lead between the junction and ground. This jumper disables into A TRIGGERING LEVEL control.

g. Connect a 10X Probe from the test oscilloscope the junction of R45—R48.

h. Set the test oscilloscope controls as follows:

| | |
|---|---|
| INPUT COUPLING | AC |
| VOLTS/DIV | .02 |
| TIME/DIV | .2 mSEC |
| TRIGGERING | |
| MODE | AUTOMATIC |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | INTERNAL |

i. Set the TRIGGER SENS R45 to midrange.

j. Rotate TRIGGER LEVEL CENTERING R24 fully counterclockwise.

k. Rotate TRIGGER LEVEL CENTERING R25 clockwise until a stable display 2 to 3 major divisions high appears on the test oscilloscope.

l. If no stable display appears on the test oscilloscope, rotate the TRIGGER SENS R45 slightly clockwise, then repeat part k.

m. Change the Triggering SLOPE switch to — and check for a stable display on the test oscilloscope. If necessary readjust the TRIGGER LEVEL CENTERING R25 slightly so as to obtain a stable test oscilloscope in both positions of the A SLOPE switch.

n. If a stable test oscilloscope display can not be obtained for both B SLOPE switch positions, rotate the TRIGGER SENS R45 slightly clockwise and repeat part m.

o. After obtaining a stable test oscilloscope display for both B SLOPE switch positions, rotate the TRIGGER SENS R45 slightly counterclockwise. Again check for a stable test oscilloscope display in both positions of B SLOPE switch. TRIGGER LEVEL CENTERING R25 may have to be readjusted slightly.

p. Continue rotating the TRIGGER SENS R45 slightly counterclockwise and then checking the test oscillo-

scope display until a stable test oscilloscope display can not be obtained for both positions of the Triggering SLOPE switch.

q. Rotate the TRIGGER SENS R45 just enough clockwise to permit a stable test oscilloscope display to be obtained for both positions of the Triggering SLOPE switch. Slight readjustment of TRIGGER LEVEL CENTERING R25 will probably be necessary.

**17. Adjust B INT TRIG DC LEVEL (B Internal Trigger DC Level) R9—B Sweep Trigger**

a. Set the AMPLITUDE CALIBRATOR switch to .5 VOLTS.

b. Set the B SOURCE switch to NORM INT.

c. Adjust the TU-7 Variable control so the displayed waveform is 5 mm peak-to-peak in amplitude.

d. Using the TU-7 Vertical Position control, center the display for equal amplitude above and below the center graticule line.

e. Set the B COUPLING switch to DC.

f. Adjust the B INT TRIG DC LEVEL R9 control (see Fig. 5-6) to obtain a stable display. (With the B SLOPE switch set to +, the sweep trace should start on the positive-going rise of the calibrator waveform.)

**18. Check Internal Triggering—B Sweep Trigger**

a. Set the B COUPLING switch to AC.

b. Adjust the TU-7 Variable control until the display is 2 mm peak-to-peak in amplitude.

c. Disconnect the jumper clip lead.

d. Adjust the B TRIGGERING LEVEL control to obtain a stable display.

e. Operate the B SLOPE switch. Check for stable time-base triggering on the —slope when the SLOPE switch is set to — and stable triggering on the

**19. Check B TRIGGERING LEVEL Control Zero Set—B Sweep Trigger**

a. Check that the B TRIGGERING LEVEL control is set to 0 and the SLOPE switch is set to +.

b. Connect the VOM between R17/C18/R18 junction and ground.

c. Carefully rotate the B TRIGGERING LEVEL control to obtain a reading of exactly zero volts on the VOM.

d. If the B TRIGGERING LEVEL knob is set properly on the control shaft, the white dot on the knob should be directly below the 0 on the front panel. If the white dot does not point accurately to 0, disconnect the VOM, loosen the setscrew in the knob and reposition the knob.

e. After tightening the knob, set the knob to 0, reconnect the VOM, and recheck the reading. The VOM reading should be zero when the B TRIGGERING knob is set to 0.

NOTE

A dc-coupled test oscilloscope with a 10X probe can be used in place of the VOM to perform this step. As another method the white dot on the B TRIGGERING LEVEL knob should point to 0 to obtain stable triggering when operating the B SLOPE switch as directed in step 18.

f. Disconnect the VOM or 10X probe, whichever one is used.

h. Disconnect the coax cables, 'T' connector, and set the AMPLITUDE CALIBRATOR switch to OFF.

**20. Adjust SWP/MAG REGIS (Sweep/Magnifier Registration) R569—Horizontal Amplifier**

a. Set the Main Time Base (B) Front-panel controls to these settings:

| | |
|---|---|
| TRIGGERING LEVEL | About 25° clockwise from 0 |
| MODE | AUTO |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | NORM INT |
| TIME/CM | 1 mSEC |

(All the remaining front-panel control settings up to this point in the procedure are listed in Table 5-5.)

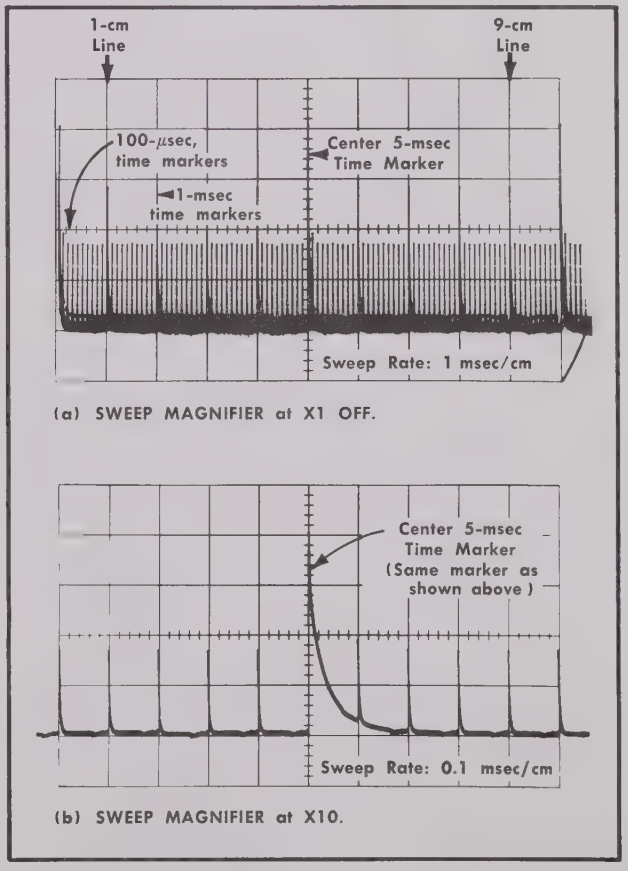

1-cm Line
9-cm Line
100-μsec, time markers
Center 5-msec Time Marker
1-msec time markers
Sweep Rate: 1 msec/cm
(a) SWEEP MAGNIFIER at X1 OFF.
Center 5-msec Time Marker (Same marker as shown above)
Sweep Rate: 0.1 msec/cm
(b) SWEEP MAGNIFIER at X10.

Fig. 5-7. Time marker displays.

TABLE 5-5

| | |
|---|---|
| CRT Controls | |
| INTENSITY | ≈3.7 |
| FOCUS | ≈5 |
| ASTIGMATISM | ≈5 |
| SCALE ILLUM | ≈8 |
| Time Base A | |
| TRIGGERING LEVEL | 0; knob pulled outward |
| TRIGGERING— | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | NORM INT |
| VARIABLE (TIME/CM) | CALIBRATED |
| TIME/CM | .5 mSEC |
| Horizontal Display | |
| HORIZONTAL DISPLAY | B |
| SWEEP MAGNIFIER | X1 OFF |
| Single Sweep Switch | NORMAL |
| Main Time Base (B) | |
| TRIGGERING LEVEL | Knob pulled outward |
| VARIABLE (TIME/CM) | CALIBRATED |
| BRIGHTNESS | Fully cw |
| Other Controls | |
| DELAY-TIME MULTIPLIER | 1.00 |
| HORIZONTAL POSITION | Approximately centered |
| VERNIER (HORIZONTAL POSITION) | Centered |
| AMPLITUDE CALIBRATOR | OFF |
| Type TU-7 | |
| Vertical Position | Centered |
| Variable | ≈3 |
| Test Function | Low Load |

b. Apply 100-$\mu$sec, 1 msec and 5-msec time markers from the time-mark generator through a coaxial cable to the TU-7 Ext Input connector.

c. Set the TU-7 Variable control so the display is about 4 centimeters in amplitude.

d. Center the display vertically using the TU-7 Vertical Position control.

e. Adjust, if necessary, the B TRIGGERING LEVEL control to obtain stable triggering on the 5-msec time marks. Fig. 5-7a shows the time markers displayed with respect to the graticule markings. Use the HORIZONTAL POSITION control to position the center 5-msec time marker to the center of the graticule as shown in the illustration.

f. Set the SWEEP MAGNIFIER switch to X10. Position the 5-msec time marker to graticule center (see Fig. 5-7b) and then set the SWEEP MAGNIFIER switch to X1 OFF.

g. Adjust the SWP/MAG REGIS R569 control (see Fig. 5-2) to position the center 5-msec time marker to graticule center. If necessary, repeat steps 22f and 22g until there is no movement of the 5-msec time marker as the SWEEP MAGNIFIER switch is changed from X10 to X1 OFF.

**21. Adjust X10 CAL (X10 Magnified Sweep Calibration) R544—Horizontal Amplifier**

a. Set the SWEEP MAGNIFIER switch to X10.

b. Adjust the X10 CAL R544 control (see Fig. 5-2) so there is 1 marker per cm from the 1-cm to 9-cm graticule lines. For accurate adjustment the X10 CAL control should be adjusted so the markers at the 1- and 9-cm graticule lines coincide exactly with the 1-cm and 9-cm graticule lines.

NOTE

The following hints should help you to obtain the best results in checking and adjusting the time-base sweep rates:

It is quite difficult to detect small sweep rate errors on the order of 1 or 2% unless measurement is made using most of the graticule width. **It is therefore recommended that the sweep rates be checked for correct linearity and timing using the center 8 cm and the middle 80% of the display as shown in Fig. 5-8.** With the measurement taken over a distance of 8 cm, the adjustment can be made more accurately. Further on in the procedure when you check the non-adjustable sweep rates without using the DELAY-TIME MULTIPLIER control a 1.6 mm error would indicate a 2% sweep-rate error as shown in Fig. 5-8. The marker peak provides an excellent reference point, particularly if the amplitude is such that the base line is below the crt viewing area and the tips of the markers are located in the center of the crt. When using the sine waves for markers at the higher sweep rates, set the TU-7 Variable and Vertical Position Controls so the lower half of the display is positioned below the crt and the tips of each cycle are near the center of the crt. By increasing the amplitude of the display in this manner each marker or cycle tip appears much narrower.

The adjustable sweep rates should be set for maximum accuracy. When adjusting the timing capacitors, use a screwdriver having a metal tip and a non-metallic shank to minimize capacitance disturbance to the circuit. This will also lessen the chance of accidentally grounding connections elevated above or below ground.

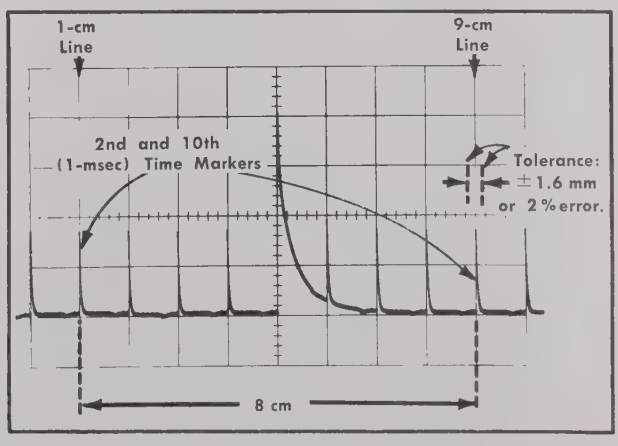



Fig. 5-8. Determining sweep-rate accuracy.

**22. Adjust X1 CAL (X1 Sweep Calibration) R566—Horizontal Amplifier**

a. Set the SWEEP MAGNIFIER switch to X1 OFF.

b. Adjust the X1 CAL R566 control (see Fig. 5-2) so the 1-msec markers are spaced 1-cm apart and so the 1-msec markers at the 1-cm and 9-cm points coincide with the graticule lines.

c. Due to some interaction between the X10 CAL and X1 CAL adjustments, repeat steps 23 and 24 until the timing is correct.

**23. Check MAG ON Neon—Horizontal Amplifier**

a. Check that the MAG ON neon lights when the SWEEP MAGNIFIER switch is set to each one of these positions: X2, X5, and X10.

b. Set the SWEEP MAGNIFIER switch to X1 OFF.

**24. Adjust B SWEEP LENGTH R125—B Sweep Generator**

a. Check that the display is positioned to start at the left side of the graticule or 0-cm line.

b. Adjust the B SWEEP LENGTH R125 control (see Fig. 5-2) for a sweep length of 10.5 cm. When the adjustment is made correctly, there will be five 100-$\mu$sec time marks after the 5-msec time mark located at the 10-cm graticule line.

**25. Check B VARIABLE (TIME/CM) and UNCALIBRATED NEON—'B' Sweep Timing Switch**

a. Set the time-mark generator for 10-msec and 5-msec timemark output.

b. Adjust the B TRIGGERING LEVEL control to trigger on the 10-msec time markers.

c. Rotate the B VARIABLE (TIME/CM) control a few degrees in the counterclockwise direction. The UNCALIBRATED neon should light as the switch on the control is activated.

d. Rotate the B VARIABLE control to its fully counterclockwise position. At least 25 msec of time for a distance of 10 cm should be displayed to indicate a ratio of 2.5 to 1. That is, the 5-msec markers should be spaced at intervals of 2 cm or less.

e. Set the B VARIABLE control to the CALIBRATED position.

**26. Adjust DELAY START R418—Delay Pickoff**

a. Apply 1-msec only time markers to the TU-7 Ext Input connector.

b. Set the oscilloscope front-panel controls to the following positions:

| | |
|---|---|
| A TRIGGERING MODE | AUTO |
| A TIME/CM | 10 $\mu$sec |
| HORIZONTAL DISPLAY | B INTENS BY 'A' |

(The remaining front-panel controls at this point in the procedure are set to the positions listed in Table 5-6.)

TABLE 5-6

| | |
|---|---|
| CRT Controls | |
| INTENSITY | ≈3.5 |
| FOCUS | ≈5 |
| ASTIGMATISM | ≈5 |
| SCALE ILLUM | ≈8 |
| Time Base A | |
| TRIGGERING LEVEL | 0; knob pulled outward |
| TRIGGERING— | |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | NORM INT |
| VARIABLE (TIME/CM) | CALIBRATED |
| Horizontal Display | |
| SWEEP MAGNIFIER | X1 OFF |
| Single Sweep Switch | NORMAL |
| Main Time Base (B) | |
| TRIGGERING LEVEL | 0; knob pulled outward |
| TRIGGERING— | |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | NORM INT |
| VARIABLE (TIME/CM) | CALIBRATED |
| TIME/CM | 1 mSEC |
| BRIGHTNESS | Fully cw |
| Other Oscilloscope Controls | |
| DELAY-TIME MULTIPLIER | 1.00 |
| HORIZONTAL POSITION | Approximately centered |
| VERNIER (HORIZONTAL POSITION) | Centered |
| AMPLITUDE CALIBRATOR | OFF |
| Type TU-7 | |
| Variable | ≈3.5 |
| Test Function | Low Load |
| Vertical Position | Approximately centered |

c. Set the TU-7 Variable control so the display is about 3 cm in amplitude.

d. Set the B MODE switch to TRIG and adjust the B TRIGGERING LEVEL control for stable triggering on the 1-msec time markers.

e. Adjust the BRIGHTNESS control in the counterclockwise direction and the INTENSITY control in the clockwise direction to make the brightened portion of the display easily distinguishable (see Fig. 5-9a).

f. Rotate the DELAY-TIME MULTIPLIER control fully counterclockwise and check for a dial reading of 0.15. If the dial reading is not 0.15, loosen the set screw in the knob. Reposition the knob so the dial reading is 0.15 and then retighten the set screw.

g. Rotate the DELAY-TIME MULTIPLIER control fully clockwise and check for a minimum dial reading of 10.15.

h. Rotate the DELAY-TIME MULTIPLIER control to read 1.00.

i. Adjust the DELAY START R418 control (see Fig. 5-2) so the 2nd 1-msec time marker on the B display is brightened (see Fig. 5-9a).

i. Set the HORIZONTAL DISPLAY switch to A DLY'D and set the DELAY START R148 control so the rising portion is displayed (see Fig. 5-9b) at the very start of the sweep trace. The A display is a 100X magnification of the brightened portion of the B display.

### 27. Adjust DELAY STOP R415—Delay Pickoff

a. Set the DELAY-TIME MULTIPLIER control to 9.00.

b. Set the HORIZONTAL DISPLAY switch to B INTENS BY 'A'.

c. Adjust the DELAY STOP R415 control (see Fig. 5-2) so the 10th 1-msec marker on the B display is brightened.

d. Set the HORIZONTAL DISPLAY switch to A DLY'D and adjust the DELAY STOP, R415, so the rising portion of the marker is displayed (see Fig. 5-9b) at the very start of the trace. If the adjustment is made correctly, the display obtained in this step should appear the same as the display obtained when performing step 26j and as shown in Fig. 5-9b.

e. Due to interaction between the DELAY START and DELAY STOP adjustments, set the DELAY-TIME MULTIPLIER control to 1.00 and repeats steps 26j through 27d until the A sweep starts at the same point on the 1-cm and 9-cm time markers, respectively.

### 28. Check Incremental Accuracy—Delay Pickoff

a. Set the DELAY-TIME MULTIPLIER control so the A sweep starts on the rising portion of the 1-msec markers for each setting as given in Table 5-7.

TABLE 5-7

| Delay-Time Multiplier Control Setting | Tolerance |
|---|---|
| 1.00 | 0 (Adjusted) |
| 2.00 | ±4.0 minor div. |
| 3.00 | ±4.0 minor div. |
| 4.00 | ±4.0 minor div. |
| 5.00 | ±4.0 minor div. |
| 6.00 | ±4.0 minor div. |
| 7.00 | ±4.0 minor div. |
| 8.00 | ±4.0 minor div. |
| 9.00 | 0 (Adjusted) |

b. Disconnect the coaxial cable from the TU-7 Ext Input connector.

### 29. Adjust C186 (Unblanking Compensator Capacitor)—B Sweep Generator

a. Set the oscilloscope and TU-7 front-panel controls to these settings:

| | |
|---|---|
| TU-7 Test Function | Gain Set |
| 'A' TRIGGERING LEVEL | Fully cw |
| 'A' TIME/CM | 50 μSEC |
| HORIZONTAL DISPLAY | A |
| 'B' TRIGGERING LEVEL | Fully cw |
| 'B' MODE | AUTO |
| 'B' TIME/CM | 50 μSEC |
| BRIGHTNESS | Fully cw |
| INTENSITY | Slightly below normal |

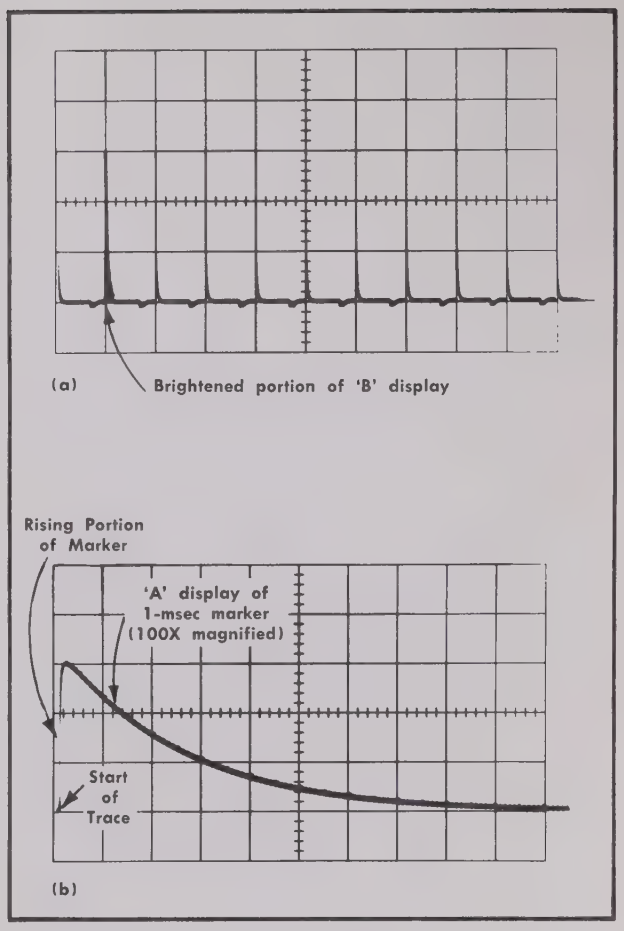



**Fig. 5-9. Adjusting the DELAY START R418 control for proper A delayed-sweep starting time.**

b. Use the TU-7 Vertical Position control to center the trace on the crt.

c. Switch the HORIZONTAL DISPLAY back and forth between A and B and set the BRIGHTNESS control so the B trace is the same brightness as the A trace along the distance from about 2 cm to 10 cm.

d. Adjust C186 (see Fig. 5-10) so the starting portion ot the B trace is the same brightness as the starting portion of the A trace.

NOTE

Adjustment of C186 has the greatest effect on the first 8 mm distance of the B trace.

e. Reconnect the coaxial cable from the time-mark generator to the TU-7 Ext Input Connector.

### 30. Adjust C90C (10-μSEC B Sweep-Rate Timing to DELAY-TIME MULTIPIER)—B Sweep Timing Switch

a. Set the time-mark generator for 10-μsec time-marker output.

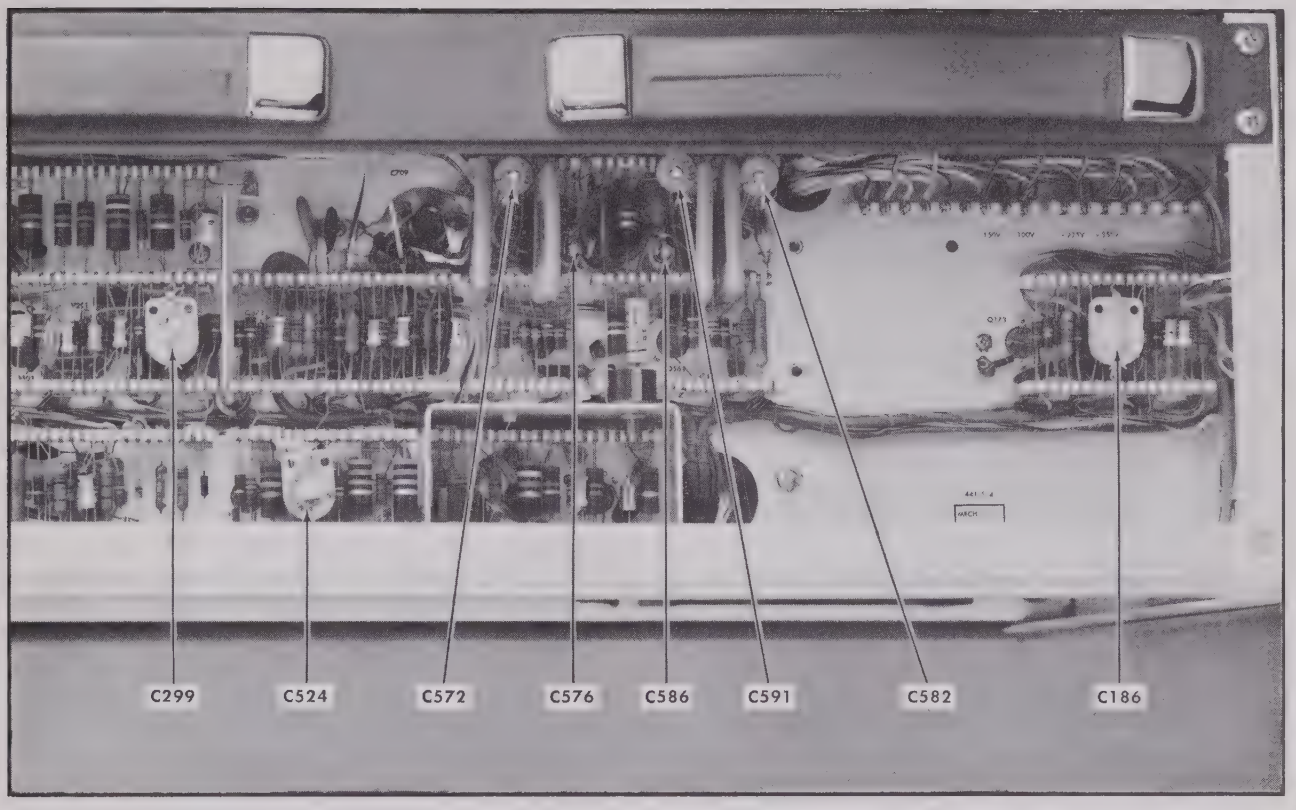



**Fig. 5-10. Calibration adjustment locations.**

b. Set the TU-7 and oscilloscope front-panel controls as follows:

| | |
|---|---|
| TU-7 Test Function | Low Load |
| A Time/CM | 1 μSEC |
| HORIZONTAL DISPLAY | B INTENS BY 'A' |
| B MODE | TRIG |
| B TIME/CM | 10 μSEC |
| BRIGHTNESS | Near midrange |
| INTENSITY | Normal intensity |

c. Adjust the B TRIGGERING LEVEL control to obtain a stable display.

d. Set the TU-7 Variable control so the 'B' display is about 4 cm in amplitude and center the display vertically using the Vertical Position control.

e. Set the DELAY-TIME MULTIPLIER so the 50% point on the rising portion of the 2nd 10-μsec time marker is brightened. Set the HORIZONTAL DISPLAY switch to A DLY'D and adjust the DELAY-TIME MULTIPLIER control to set the 50% point with greater accuracy.

f. Note the DELAY-TIME MULTIPLIER dial reading in relation to 1.00.

g. Set the HORIZONTAL DISPLAY switch to B INTENS BY 'A'.

h. Set the DELAY-TIME MULTIPLIER control to read exactly 8.00 plus the dial reading obtained in the previous step.

i. Adjust C90C (see Fig. 5-2) so the 50% point on the rising portion of the 10th time marker is the starting point of the brightened 10th time marker. Set the HORIZONTAL DISPLAY switch to A DLY'D to observe when the 50% point is reached accurately. After making the adjustment, set HORIZONTAL DISPLAY switch to B INTENS BY 'A'.

j. Since there is interaction which affects the dial reading obtained in step g, repeat steps f through i until the DELAY-TIME MULTIPLIER dial indicates a difference of exactly 8.00 between the 2nd and 10th time markers.

k. Check that the HORIZONTAL DISPLAY switch is set to B INTENS BY 'A'.

**31. Adjust C90B (1-μSEC B Sweep-Rate Timing to DELAY-TIME MULTIPLIER)—B Sweep Timing Switch**

a. Set the time-mark generator for 1-μsec time-marker output.

b. Set the A TIME/CM switch to .1 μSEC and the B TIME/CM switch to 1 μSEC.

c. Adjust the TU-7 Variable control so the display is 4 cm in amplitude.

d. Push the B TRIGGERING LEVEL knob in; adjust the B TRIGGERING LEVEL control to trigger on the time markers.

e. Set the DELAY-TIME MULTIPLIER control so the 2nd time marker on the B display is brightened starting at the 50% point on the rising portion of the marker. Set the HORIZONTAL DISPLAY switch to A DLY'D to set the 50% point accurately (similar to the procedure used in step 30e).

f. Note the DELAY-TIME MULTIPLIER dial reading.

g. Set the HORIZONAL DISPLAY switch to B INTENS BY 'A'.

h. Set the DELAY-TIME MULTIPLIER control to read exactly 8.00 plus the dial reading noted in the previous step.

i. Adjust C90B (see Fig. 5-2) so the 50% starting point on rising portion of the 10th time marker is brightened. Set the HORIZONTAL DISPLAY switch to A DLY'D to observe when the point is accurately reached, then set the HORIZONTAL DISPLAY switch to B INTENS BY 'A'.

j. Due to interaction that affects the DELAY-TIME MULTIPLIER reading that was obtained for the 2nd time marker, repeat steps e through i until the DELAY-TIME MULTIPLIER dial indicates an exact 8.00 difference between the 2nd and 10th time markers.

k. Check that the HORIZONTAL DISPLAY switch is set to B INTENS BY 'A'.

**32. Adjust C90A (.5-μSEC B Sweep-Rate Timing to the DELAY-TIME MULTIPLIER)—B Sweep Timing Switch**

a. Check that the time-mark generator is set for 1-μsec marker output.

b. Connect a coax cable from the trigger out connector on the time-mark generator to the B TRIGGER INPUT connector.

c. Set the trigger rate of the time-mark generator for 10-μsec trigger output.

d. Set the B TIME/CM switch to .5 μSEC and set the B source switch to EXT.

e. Adjust C90A (see Fig. 5-2) for 1 marker per 2 cm. Disregard the first marker when making the adjustment for correct timing.

**33. Adjust C99 (B Sweep Output Compensation) B Sweep Generator**

a. Set the time-mark generator for 10-mc sine-wave output.

b. Set the HORIZONTAL DISPLAY switch to B.

c. Set the B TIME/CM switch to .1 μSEC.

d. Use the TU-7 Vertical Position control to center the display vertically and adjust the variable control so the display is about 4 cm in amplitude.

e. Using the oscilloscope HORIZONTAL POSITION control, position the tip of the 2nd sine wave to align with the 1-cm graticule line.

f. Adjust C99 (see Fig. 5-2) for correct timing of 1 cycle per cm. (C99 is primarily a linearity adjustment.)

g. Due to interaction between the adjustment of C99 and C90A, set the HORIZONTAL DISPLAY switch to B INTENS BY 'A' and repeat the procedure for the adjustments outlined in steps 32a through 33f until the desired results are obtained.

h. Set the HORIZONTAL DISPLAY switch to A DLY'D and the DELAY-TIME MULTIPLIER control to 1.00.

i. Using the HORIZONTAL POSITION control, position the display to the right so the start of the sweep can be observed.

j. Adjust the B TRIGGERING LEVEL control so the sweep starts at the 50% point on the rising portion of the first sine wave.

k. Using the TU-7 Vertical Position and the oscilloscope HORIZONTAL POSITION controls, position starting point of the first sine wave behind the intersection of a vertical and a horizontal graticule line. Use this intersection as a reference point.

l. Set the DELAY-TIME MULTIPLIER control to 9.00.

m. Readjust C90A to obtain the same starting point on the first displayed sine wave as was obtained in step k.

**34. Check .2-μSEC/CM Sweep Rate—B Sweep Timing Switch**

a. Set the DELAY-TIME MULTIPLIER control to 1.00 and the B TIME/CM switch to .2 μSEC.

b. Note the starting point of the sweep on the first sine wave.

c. Set the DELAY-TIME MULTIPLIER control to obtain the same starting point with the control set near 9.00. Tolerance is ±1% or ±8 minor divisions.

**35. Recheck .5-μSEC/CM Sweep Rate—B Sweep Timing Switch**

a. Set the time-mark generator for 5-mc sine-wave output.

b. Set the B TIME/CM switch to .5 μSEC.

c. Set the DELAY-TIME MULTIPLIER control to 1.00.

d. Adjust the B TRIGGERING LEVEL control to make the sweep start at a convenient reference point on the first sine wave.

e. Set the DELAY-TIME MULTIPLIER control to about 9.00 so the sweep starts at the same point as in step 37d. Note the dial reading from 9.00. Tolerance is ±1% or ±8 minor divisions.

**36. Check 2-μSEC through 5-SEC/CM Sweep Rates—B Sweep Timing Switch**

a. Set the B TIME/CM switch to 2 μSEC and the B TRIGGERING SOURCE switch to NORM INT.

b. Set the HORIZONTAL DISPLAY switch to B INTENS BY 'A'.

c. Starting with the 2-μSEC/CM B sweep rate, check the Main Time Base (B) sweep rates using Table 5-7 as a guide. Use the DELAY-TIME MULTIPLIER control and the A DLY'D position of the HORIZONTAL DISPLAY switch to determine the sweep-rate timing accuracy. The difference in dial readings between the "1.00" and "9.00" setting should be 8.00 within a tolerance of ±1% for each of the sweep rates.

TABLE 5-7

| B TIME/CM Setting Switch | A TIME/CM Switch Setting | Time-Mark Generator Output | Markers Per Centimeter on B Display |
|---|---|---|---|
| 2 μSEC | .1 μSEC | 1 μsec | 2 |
| 5 μSEC | .1 μSEC | 5 μsec | 1 |
| 10 μSEC* | 1 μSEC | 10 μsec | 1 |
| 20 μSEC | 1 μSEC | 10 μsec | 2 |
| 50 μSEC | 1 μSEC | 50 μsec | 1 |
| .1 mSEC | 10 μSEC | 100 μsec | 1 |
| .2 mSEC | 10 μSEC | 100 μsec | 2 |
| .5 mSEC | 10 μSEC | 500 μsec | 1 |
| 1 mSEC* | .1 mSEC | 1 msec | 1 |
| 2 mSEC | .1 mSEC | 1 msec | 2 |
| 5 mSEC | .1 mSEC | 5 msec | 1 |
| 10 mSEC | 1 mSEC | 10 msec | 1 |
| 20 mSEC | 1 mSEC | 10 msec | 2 |
| 50 mSEC | 1 mSEC | 50 msec | 1 |
| .1 SEC | 10 mSEC | 100 msec | 1 |
| .2 SEC | 10 mSEC | 100 msec | 2 |
| .5 SEC | 10 mSEC | 500 msec | 1 |
| 1 SEC | .1 SEC | 1 sec | 1 |
| 2 SEC | .1 SEC | 1 sec | 2 |
| 5 SEC | .1 SEC | 5 sec | 1 |

***Adjusted previously.**

**37. Adjust C572 and C582 (High-Speed Sweep Length Compensation)—Horizontal Amplifier**

a. Set the oscilloscope front panel controls to these settings:

| | |
|---|---|
| HORIZONTAL DISPLAY | B |
| B TRIGGERING SOURCE | EXT |
| B TIME/CM | .1 μSEC |

b. Set the time-mark generator for 10-mc sine-wave output.

c. Adjust the INTENSITY control so the display is easily visible while adjusting the B TRIGGERING LEVEL control to obtain a stable display.

d. Using the TU-7 Vertical Position control, center the display. Adjust the Variable control so the display is about 4 cm in amplitude.

e. Adjust the HORIZONTAL POSITION control to position the 2nd cycle to align with the 1-cm graticule line.

f. Recheck the sweep-rate timing for 1 cycle per cm. If timing is not accurate, carefully readjust C99 for exact timing of 1 cycle per cm from the 1-cm graticule line to the 9-cm graticule line.

g. Check that C576 and C586 (see Fig. 5-10) slug-adjusting screws are about six turns above the metal wiper contacts of the capacitors.

h. Set the time-mark generator for 50-mc sine-wave output.

i. Set the TU-7 Variable control so the display is about 4 cm in amplitude.

j. Set the SWEEP MAGNIFIER switch to X10.

k. Adjust the B TRIGGERING LEVEL control to obtain a stable display.

l. Adjust C572 and C582 (see Fig. 5-10) for maximum center sweep expansion. (Use a low-capacitance alignment tool when making the adjustments.)

**38. Adjust C591 (High-Speed Sweep Linearity)—Horizontal Amplifier**

Adjust C591 (see Fig. 5-10) for best display linearity of 1 cycle per 2 cm.

**39. Adjust C576 and C586 (High-Speed Timing Adjustments)—Horizontal Amplifier**

Adjust C576 and C586 in equal increments for best timing of 1 cycle per 2 cm from the 2-cm graticule line to the 8-cm graticule line.

NOTE

If best timing cannot be obtained and the sweep seems too long, readjust C572 slightly to reduce the displayed gain. If C576 and C586 do not seem to have enough range, repeat steps 39 through 41. If repeat adjustment procedure causes timing to worsen, C576 and C586 slug-adjusting screws are probably turned in too far. Try presetting the C576 and C586 screws about 7 or 8 turns above the contacts and then repeat steps 39 through 41.

**40. Adjust C557H (X10 SWEEP MAGNIFIER Compensation)—Horizontal Amplifier**

a. Rotate the HORIZONTAL POSITION and VERNIER controls clockwise so the start of the sweep (or display) can be seen. Then, position the tip of a cycle occurring 40 nsec or more from the start of the sweep to coincide with the 1-cm graticule line.

b. Adjust C557H (see Fig. 5-2) for best timing of 1 cycle per 2 cm from the 1-cm to 8-cm graticule

lines. If necessary, retouch C591 to obtain best linearity.

c. Using the HORIZONTAL POSITION control, position the center of the sweep into view. If the timing needs to be improved, retouch C572 and/or repeat steps 39l through 42c.

d. Set the SWEEP MAGNIFIER switch to OFF.

e. Using the HORIZONTAL POSITION and VERNIER controls, position the display so the end of the sweep coincides with the 7-cm graticule line.

f. Set the SWEEP MAGNIFIER switch to X10.

g. Note the timing error of the display from the 1-cm to the 9-cm graticule lines; tolerance should be within ±5% or ±4 mm.

**41. Check Timing Accuracy—Horizontal Amplifier**

Check the timing accuracy of the display between the 4th cm and 80th cm of the sweep. Magnified-timing in this region must be within ±5% or less. If, in the 20th-cm region some non-linearity is observed, readjust C591 to make the sweep more linear.

NOTE

**With some time and care spent in making the adjustments described in steps 39 through 43 as accurately as possible, the magnified sweep timing can be adjusted to ±5% or better.**

**42. Adjust C557F (X5 SWEEP MAGNIFIER Compensation)—Horizontal Amplifier**

a. Set the SWEEP MAGNIFIER switch to X5.

b. Adjust C557F (see Fig. 5-2) for 1 cycle per cm after the first 2 cm from the start of the sweep.

**43. Adjust C557D (X2 SWEEP MAGNIFIER Compensation)—Horizontal Amplifier**

a. Set the SWEEP MAGNIFIER switch to X2.

b. Adjust C557D (see Fig. 5-2) for 2½ cycles per cm after the first cm from the start of the sweep.

**44. Adjust A SWEEP LENGTH R325—A Sweep Generator**

a. Set the time-mark generator for 100-μsec, 1-msec and 5-msec time-marker output.

b. Set the front-panel controls of the oscilloscope to these settings.

| | |
|---|---|
| A TIME/CM | 1 mSEC |
| HORIZONTAL DISPLAY | A |
| SWEEP MAGNIFIER | X1 OFF |

Table 5-8 lists the settings of the remaining front panel controls up to this point in the procedure.

TABLE 5-8

| | |
|---|---|
| CRT Controls | |
| INTENSITY | ≈4 |
| FOCUS | ≈5 |
| ASTIGMATISM | ≈5 |
| SCALE ILLUM | ≈8 |
| Time Base A | |
| TRIGGERING LEVEL | +20°; knob pulled outward |
| TRIGGERING— | |
| MODE | AUTO |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | NORM INT |
| VARIABLE (TIME/CM) | CALIBRATED |
| Horizontal Display | |
| Single Sweep Switch | NORMAL |
| Main Time Base (B) | |
| TRIGGERING LEVEL | ≈0; knob pushed in |
| TRIGGERING— | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | EXT |
| VARIABLE (TIME/CM) | CALIBRATED |
| TIME/CM | .1 mSEC |
| BRIGHTNESS | Fully cw |
| Other Oscilloscope Controls | |
| DELAY-TIME MULTIPLIER | 9.00 |
| HORIZONTAL POSITION | +45° from center |
| VERNIER (HORIZONTAL POSITION) | Centered |
| AMPLITUDE CALIBRATOR | OFF |
| Type TU-7 | |
| Variable | ≈5 |
| Test Function | Low Load |
| Vertical Position | Approximately centered |

c. Set the TU-7 Variable control so the display is 4 cm in amplitude.

d. Adjust the A TRIGGERING LEVEL control so the sweep triggers on the 5-msec time markers.

e. Set the HORIZONTAL POSITION and VERNIER controls so the end of the sweep is located near the center of the crt.

f. Set the SWEEP MAGNIFIER switch to X10.

g. Set the A SWEEP LENGTH R235 control (see Fig. 5-2) so there are five 100-μsec markers after the last 5-msec marker. Thus the A sweep length is 10.5 cm long.

**45. Adjust A SWP CAL (A Sweep Calibration) R290Y —A Sweep Timing Switch**

a. Set the HORIZONTAL POSITION and VERNIER controls to position the start of the display at the 0-cm graticule line. Then, set the controls so the 2nd 100-μsec marker aligns with the 1-cm graticule line.

b. Adjust the A SWP CAL R290Y control (see Fig. 5-2) so the 100-μsec markers are spaced 1 cm apart and so the 2nd and 10th 100-μsec markers coincide with their 1-cm and 9-cm graticule lines, respectively.

**46. Check A VARIABLE (TIME/CM) and UNCALIBRATED Neon—A Sweep Timing Switch**

a. Set the time-mark generator for 10-msec and 5-msec time-marker output.

b. Set the SWEEP MAGNIFIER switch to X1 OFF.

c. Set the HORIZONTAL POSITION control to position the display to start at the 0-cm graticule line.

d. Adjust the TU-7 Variable control so the 10-msec markers are about 4-cm in amplitude.

e. Adjust the A TRIGGERING LEVEL control to trigger the sweep on the 10-msec markers.

f. Rotate the A VARIABLE (TIME/CM) control a few degrees in the counterclockwise direction. Check that the UNCALIBRATED neon lights as the switch on the control is activated.

g. Rotate the A VARIABLE control to its fully counterclockwise position. At least 25 msec of time for a distance of 10 cm should be displayed to indicate a ratio of at least 2.5 to 1. That is, each 5-msec marker should be spaced at intervals of 2 cm or less.

h. Set the A VARIABLE control to the CALIBRATED position.

**47. Adjust C290C (10-μSEC A Sweep-Rate Timing) —A Sweep Timing Switch**

a. Set the time-mark generator for 10-μsec time marker output.

b. Set the A TIME/CM switch to 10 μSEC.

c. Set the TU-7 Variable control so the markers are about 4 cm in amplitude.

d. Adjust the A TRIGGERING LEVEL control to trigger on the 10-μsec time markers.

e. Adjust C290C (see Fig. 5-2) so the time markers are spaced 1 cm apart and for correct timing of the markers at the 1-cm and 9-cm graticule lines.

**48. Adjust C290B (1-μSEC A Sweep-Rate Timing)— A Sweep Timing Switch**

a. Set the time-mark generator for 1-μsec time-marker output.

b. Set the A TIME/CM switch to 1 μSEC.

c. Set the TU-7 Variable control so the markers are about 4 cm in amplitude.

d. Adjust C290B (see Fig. 5-2) so the time markers are spaced 1-cm apart and for correct timing of the markers at the 1-cm and 9-cm graticule lines.

NOTE

**If exact 1-cm spacing of the time markers cannot be obtained by adjusting C290B, proceed to the next step since C299 affects the linearity of the first one-half of the A sweep.**

**49. Adjust C299 (A Sweep Output Compensation) —A Sweep Generator**

a. If the markers do not coincide accurately when adjusting C290B due to some non-linearity in the A sweep, adjust C299 (see Fig. 5-10) for best linearity for the first half of the A sweep.

b. Readjust C290B for correct timing of the markers for the last half of the sweep. Repeat the adjustment of C290B and C299 for best sweep-rate timing of 1 marker per cm from the 2nd marker to the 10th marker.

**50. Adjust C290A (.5-μSEC A Sweep Rate Timing)— A Sweep Timing Switch**

a. Set the A TIME/CM switch to .5 μSEC.

b. Using the HORIZONTAL POSITION control, position the display so the tip of the 2nd marker coincides with the 1-cm graticule line.

c. Adjust C290A (see Fig. 5-2) so there is one marker every 2 cm. The 2nd and 6th markers should coincide accurately with the 1-cm and 9-cm graticule lines, respectively.

**51. Readjust C299 (.1-μSEC A Sweep Rate Timing) —A Sweep Generator**

a. Set the time-mark generator for 10-mc sine-wave output.

b. Set the A TIME/CM switch to .1 μSEC.

c. Adjust the A TRIGGERING LEVEL controls to obtain a stable display.

d. Position the 2nd sine-wave to align with the 1-cm graticule line.

e. Readjust C299 for proper timing of 1 cycle per cm from the 1-cm to 9-cm graticule lines.

f. Repeat steps 50 and 51. C299 and C290A adjustments interact.

**52. Check .1-μSEC/CM through 5-SEC/CM Sweep Rates—A Sweep Timing Switch**

a. Check that the A TIME/CM switch is set to .1 μSEC.

b. Set the A TRIGGERING MODE switch to TRIG.

c. Starting with the .1 μSEC/CM sweep rate, check each of the Time Base A sweep rates using Table 5-9 as a guide. Tolerance for the fixed (non-adjustable) sweep rates is ±2% or ±1.6 mm.

TABLE 5-9

| 'A' TIME/CM Switch Setting | Time-Mark Generator Output | Check For |
|---|---|---|
| .1 μSEC* | 10 mc | 1 cycle/cm |
| .2 μSEC | 5 mc | 1 cycle/cm |
| .5 μSEC* | 1 μsec | 1 marker/2 cm |
| 1 μSEC | 1 μsec | 1 marker/cm |
| 2 μSEC | 1 μsec | 2 markers/cm |
| 5 μSEC | 5 μsec | 1 marker/cm |
| 10 μSEC* | 10 μsec | 1 marker/cm |
| 20 μSEC | 10 μsec | 2 markers/cm |
| 50 μSEC | 50 μsec | 1 marker/cm |
| .1 mSEC | 100 μsec | 1 marker/cm |
| .2 mSEC | 100 μsec | 2 markers/cm |
| .5 mSEC | 500 μsec | 1 marker/cm |
| 1 mSEC* | 1 msec | 1 marker/cm |
| 2 mSEC | 1 msec | 2 markers/cm |
| 5 mSEC | 5 msec | 1 marker/cm |
| 10 mSEC | 10 msec | 1 marker/cm |
| 20 mSEC | 10 msec | 2 markers/cm |
| 50 mSEC | 50 msec | 1 marker/cm |
| .1 SEC | 100 msec | 1 marker/cm |
| .2 SEC | 100 msec | 2 markers/cm |
| .5 SEC | 500 msec | 1 marker/cm |
| 1 SEC | 1 sec | 1 marker/cm |
| 2 SEC | 1 sec | 2 markers/cm |
| 5 SEC | 5 sec | 1 marker/cm |

***Adjusted previously for exact timing.**

d. After checking the sweep rates, disconnect the Time-Mark Generator and interconnecting cables from the oscilloscope/TU-7 combination.

### 53. Adjust EXT HORIZ DC BAL R519—(External) Horizontal Amplifier

a. Set the front-panel controls of the oscilloscope and TU-7 to the following settings.

Oscilloscope

| | |
|---|---|
| A TRIGGERING LEVEL | Fully clockwise, pushed in |
| A MODE | AUTO |
| A SOURCE | EXT |
| A TIME/CM | 1 mSEC |
| HORIZONTAL DISPLAY | EXT X1 |
| VAR 10-1 | Fully cw |
| B TRIGGERING LEVEL | Fully ccw |

Type TU-7

| | |
|---|---|
| Vertical Position | Centered |
| Variable | ≈3 |

The remaining front-panel controls of the oscilloscope and TU-7 are already set to the positions listed in Table 5-10.

TABLE 5-10

| | |
|---|---|
| CRT Controls | |
| INTENSITY | ≈3.5 |
| FOCUS | ≈5 |
| ASTIGMATISM | ≈5 |
| SCALE ILLUM | ≈8 |
| Time Base A | |
| TRIGGERING— | |
| SLOPE | + |
| COUPLING | AC |
| VARIABLE (TIME/CM) | CALIBRATED |
| Horizontal Display | |
| SWEEP MAGNIFIER | X1 OFF |
| Single Sweep Switch | NORMAL |
| Main Time Base (B) | |
| TRIGGERING— | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | EXT |
| VARIABLE (TIME/CM) | CALIBRATED |
| TIME/CM | .1 mSEC |
| BRIGHTNESS | Fully cw |
| Other Oscilloscope Controls | |
| DELAY-TIME MULTIPLIER | 9.00 |
| HORIZONTAL POSITION | Centered |
| VERNIER (HORIZONTAL POSITION) | Centered |
| AMPLITUDE CALIBRATOR | OFF |
| Type TU-7 | |
| Test Function | Low Load |

b. Connect a single binding post adapter (item 9) to the TU-7 Ext Input connector.

c. Connect an interconnecting lead (item 12) from the adapter at the TU-7 Ext Input connector to the SWEEP A connector on the oscilloscope.

d. Connect an interconnecting lead (item 12) from the HORIZ INPUT connector to ground.

e. Using the HORIZONTAL POSITION control, position the vertical free-running sweep trace to the center of the graticule. Check that the INTENSITY control is set to make the trace visible.

f. Adjust the EXT HORIZ DC BAL R519 control (see Fig. 5-2) for no horizontal shift of the vertical trace while rotating the VAR 10-1 control.

g. Disconnect the interconnecting lead from the HORIZ INPUT connector to ground.

**54. Adjust C524 Output Compensation—(External) Horizontal Amplifier**

a. Connect a BNC T connector to the oscilloscope CAL OUT connector.

b. Connect a coaxial cable from one end of the BNC T connector to the A TRIGGER INPUT connector.

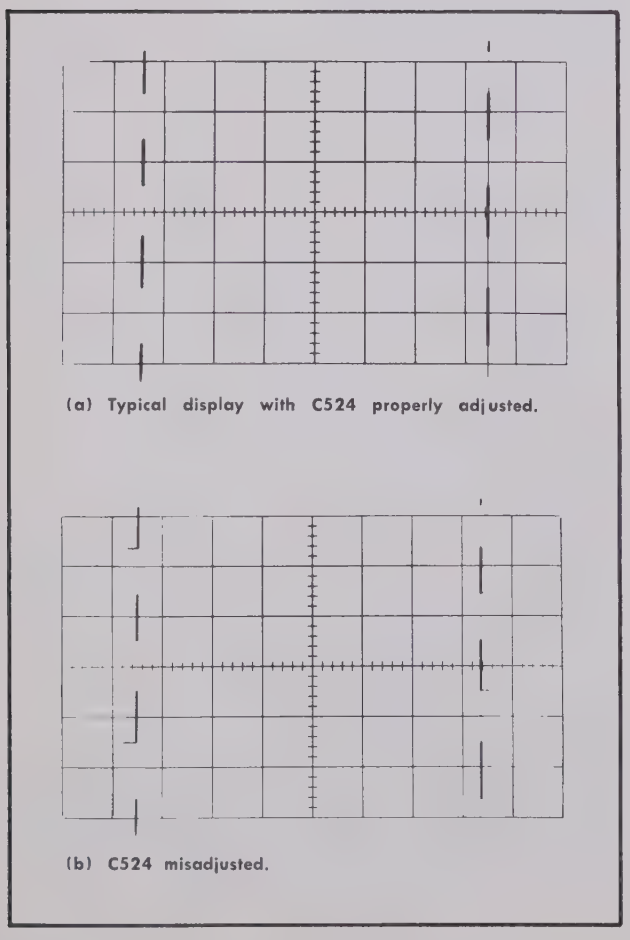
c. Connect another coaxial cable from the other end of the BNC T connector through a coaxial connector adapter (item 10) to the HORIZ INPUT connector.

d. Set the AMPLITUDE CALIBRATOR switch to .5 and adjust the A TRIGGERING LEVEL control to obtain a stable display.

e. Check that the VAR 10-1 control is set fully clockwise.

f. Set the HORIZONTAL POSITION control so the display is centered on the crt.

g. Set the TU-7 Variable control so several cycles of the calibrator waveform is displayed (see Figs. 5-11a and 5-11b).



(a) Typical display with C524 properly adjusted.

(b) C524 misadjusted.

Fig. 5-11. Typical waveform displays with C524 properly adjusted and misadjusted.

h. Adjust C524 (see Fig. 5-10) for least distorted calibrator waveform (see Fig. 5-11a); that is, for minimum fast spike or rolloff.

**55. Check Gain—(External) Horizontal Amplifier**

a. Set the AMPLITUDE CALIBRATOR switch to .1 VOLTS and check that the VAR 10-1 control is set fully clockwise.

b. Adjust the A TRIGGERING LEVEL control to obtain a stable display.

c. The calibrator waveform displayed on the crt should be greater than 1 cm in amplitude.

**56. Check VAR 10-1 Control Range—(External) Horizontal Amplifier**

a. Set the AMPLITUDE CALIBRATOR switch to .5 VOLTS.

b. Note the waveform amplitude in cm.

c. Rotate the VAR 10-1 control fully counterclockwise.

d. Check that the waveform amplitude is 1/10 the amplitude, or less, than the amplitude noted in step b.

e. Rotate the VAR 10-1 control fully clockwise.

**57. Adjust C503C (X10 Attenuator Compensation) —(External) Horizontal Amplifier**

a. Set the HORIZONTAL DISPLAY switch to EXT X10.

b. Set the AMPLITUDE CALIBRATOR switch to 5 VOLTS.

c. Adjust C503C (see Fig. 5-2) for optimum square-wave response. The display should exhibit no more than 5% hook on the positive-going or negative-going leading corner of the calibrator waveform. When C503C is properly adjusted, the calibrator waveform should appear similar to the display shown in Fig. 5-11a. Fig. 5-12 shows one form of distortion obtained if C503C is misadjusted.

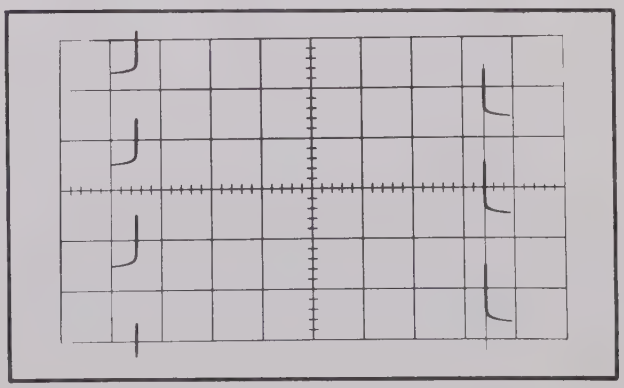


Fig. 5-12. Distortion obtained when C503C is misadjusted.

**58. Check X10 Attenuation—(External) Horizontal Amplifier**

a. Set the HORIZONTAL DISPLAY switch to EXT X1 and check that the VAR 10-1 control is set fully clockwise.

b. Set the AMPLITUDE CALIBRATOR switch to .5 VOLTS.

c. Note the waveform amplitude in cm.

d. Set the HORIZONTAL DISPLAY switch to EXT X10.

e. Set the AMPLITUDE CALIBRATOR switch to 5 VOLTS and check the amplitude of the display. The signal amplitude should be within ±3% of that amplitude noted in step 57c.

f. Set the HORIZONTAL DISPLAY switch to B.

g. Disconnect the adapters, interconnecting lead and coaxial cables.

**59. Check and/or Adjust High-Frequency Compensation—Vertical Amplifier**

a. Set the front-panel controls of the oscilloscope to the following positions:

| | |
|---|---|
| A TRIGGERING MODE | TRIG |
| B TRIGGERING LEVEL | —20° from 0 |
| B SOURCE | NORM |
| B TIME/CM | .1 μSEC |
| SWEEP MAGNIFIER | X1 OFF |
| AMPLITUDE CALIBRATOR | OFF |

b. Set the TU-7 front-panel controls as follows:

| | |
|---|---|
| Vertical Position | Centered |
| Test Function | +Pulse |
| Amplitude | ≈7.5 |

The remaining pertinent front-panel controls up to this point in the procedure are already set to the positions listed in Table 5-11.

c. Using the oscilloscope HORIZONTAL POSITION control, position the display to start near the graticule center.

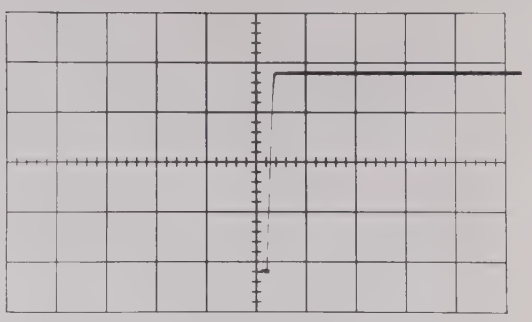
d. Set the TU-7 Amplitude and Vertical Position controls so the display is vertically centered on the crt and the amplitude of the step-waveform is exactly 4 cm.

e. Using the TU-7 Vertical Position control, position the waveform downward about 2 mm for easier visibility away from the graticule lines.

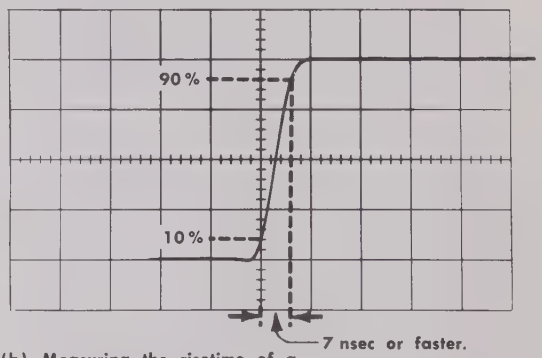
f. Adjust the INTENSITY control to increase the brightness of the display to normal viewing level.

g. Adjust the FOCUS and ASTIGMATISM controls to produce a well-defined leading top corner on the step waveform.

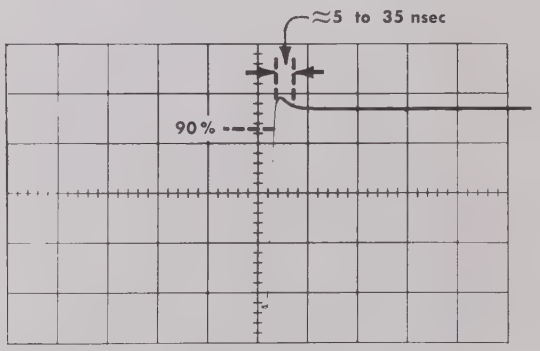
h. Examine the waveform for clean transient response. Typical waveform should appear similar to Fig. 5-13a.



(a) Normal waveform; sweep rate is 0.1 μsec/cm.




(b) Measuring the risetime of a normal waveform; sweep rate is 10 nsec/cm.




(c) Effect on waveform when C1106 is misadjusted; sweep rate is 0.1 μsec/cm.

Fig. 5-13. Vertical Amplifier compensation checks and adjustments for optimum transient response.

i. Set the SWEEP MAGNIFIER switch to X10.

j. Measure the risetime of the rising portion of the waveform from the 10% point to the 90% point (see Fig. 5-13b). The risetime should not be any slower than 6.93-nsec based on a 3-nsec risetime pulse from

the TU-7. (Take into consideration sweep-rate timing error, if any, and/or geometry in the area where the measurement is made.)

k. If the aberrations appear excessive and/or the risetime is slower than 6.93 nsec, set the SWEEP MAGNIFIER switch to X1 and adjust the high-frequency adjustments using Table 5-12 as a guide. Since the adjustments interact, it is necessary to readjust (go back over) the adjustments several times to obtain a waveform with good transient response. When making the adjustments, keep the step waveform vertically centered on the crt.

TABLE 5-11

| | |
|---|---|
| CRT Controls | |
| INTENSITY | ≈3.5 |
| FOCUS | ≈5 |
| ASTIGMATISM | ≈5 |
| SCALE ILLUM | ≈8 |
| Time Base A | |
| TRIGGERING LEVEL | +20°; knob pushed in |
| Horizontal Display | |
| HORIZONTAL DISPLAY | B |
| Single Sweep Switch | NORMAL |
| Main Time Base (B) | |
| TRIGGERING LEVEL | Knob pushed in |
| TRIGGERING— | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| VARIABLE (TIME/CM) | CALIBRATED |
| BRIGHTNESS | Fully cw |
| Other Oscilloscope Controls | |
| HORIZONTAL POSITION | —45° from center |
| VERNIER (HORIZONTAL POSITION) | Centered |
| Type TU-7 | |
| Repetition Rate | Med |

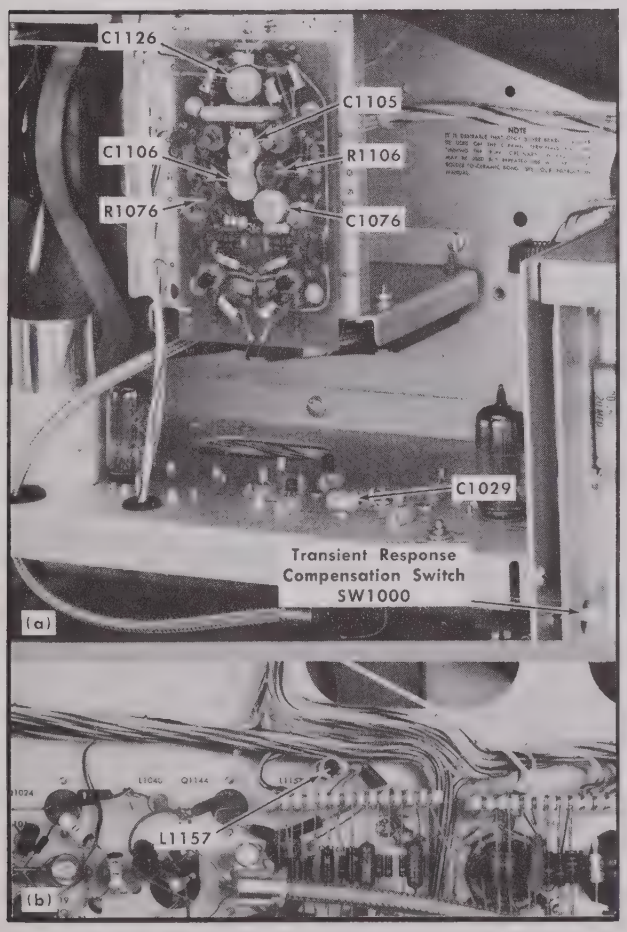



Fig. 5-14. (a) Vertical Amplifier high-frequency adjustments and Transient Response Compensation switch locations. (b) L1157 location.

TABLE 5-12

Vertical Amplifier High-Frequency Adjustments

| Adjustment | For Location See Fig. | Approximate Area Affected* |
|---|---|---|
| L1157 | 5-12B | 0-100 nsec, adjust for minimum wrinkle. |
| [1]C1027 | Located on terminals of VERT GAIN POT R1017 5-4 | 10% to 100% on the rising portion of the step function. |
| [2]C1029 | 5-12a | Termination bump at 340 ns. |
| C1076 | 5-12a | 0-15 nsec |
| C1105 | 5-12a | 1 nsec to 4 nsec |
| C1106 | 5-12a | 5 nsec to 35 nsec |
| C1126 | 5-12a | 20 nsec to 80 nsec |
| R1076 | 5-12a | 0 to 10 nsec |
| R1106 | 5-12a | 2 nsec to 20 nsec |

*Distance measured to the right starting from the 90% point on the rising portion of the waveform. For example on Fig. 5-11c.

[1]Adjust C1027 for a system risetime of 6.93 nsec or faster; based on a 3 nsec risetime pulse from the TU-7. (If C1027 is adjusted for a risetime considerably faster than 6.93 nsec and aberrations are difficult to smooth out with remaining adjustments, then make the system risetime slower, towards 6.95 nsec, by readjusting C1027. Minimize the aberrations by readjusting all of the adjustments below C1027 in Table 5-12.) This adjustment applicable for SN 630-up. (SN 470-up for RM546.)

[2]If there is no termination bump, adjust C1029 for as low a value of C as possible, or for the fastest risetime.

NOTE

To check the overall level and maintain a flat top when making the adjustments, use the different SWEEP MAGNIFIER switch positions.

**60. Check Transient Response Compensation Switch SW1000 —Vertical Amplifier**

a. Check that the B TIME/CM switch is set to .1 μSEC and the SWEEP MAGNIFIER switch is set to X10.

b. Depress the Transient Response Compensation SW-1000 (see Fig. 5-14a). Check the risetime of the step waveform (see Fig. 5-15). Overall risetime should not be any slower than 10 nsec.

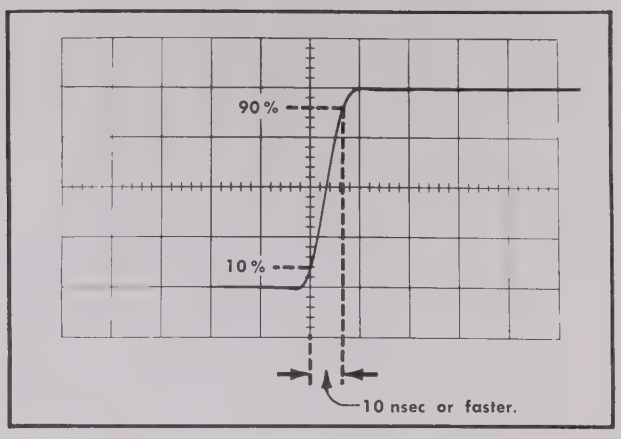



**Fig. 5-15. Measuring the risetime of a normal waveform when SW1000 is actuated; sweep rate is 10 nsec/cm.**

# SECTION 6
# PARTS LIST and DIAGRAMS

## PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix Field Office.

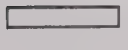
Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number including any suffix, instrument type, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix Field Office will contact you concerning any change in part number.

## ABBREVIATIONS AND SYMBOLS

| | |
|---|---|
| a or amp | amperes |
| BHS | binding head steel |
| C | carbon |
| cer | ceramic |
| cm | centimeter |
| comp | composition |
| cps | cycles per second |
| crt | cathode-ray tube |
| CSK | counter sunk |
| dia | diameter |
| div | division |
| EMC | electrolytic, metal cased |
| EMT | electroyltic, metal tubular |
| ext | external |
| f | farad |
| F & I | focus and intensity |
| FHS | flat head steel |
| Fil HS | fillister head steel |
| g or G | giga, or $10^9$ |
| Ge | germanium |
| GMV | guaranteed minimum value |
| h | henry |
| hex | hexagonal |
| HHS | hex head steel |
| HSS | hex socket steel |
| HV | high voltage |
| ID | inside diameter |
| incd | incandescent |
| int | internal |
| k or K | kilohms or kilo ($10^3$) |
| kc | kilocycle |
| m | milli, or $10^{-3}$ |
| mc | megacycle |
| mm | millimeter |
| meg or M | megohms or mega ($10^6$) |
| met. | metal |
| $\mu$ | micro, or $10^{-6}$ |
| n | nano, or $10^{-9}$ |
| $\Omega$ | ohm |
| OD | outside diameter |
| OHS | oval head steel |
| p | pico, or $10^{-12}$ |
| PHS | pan head steel |
| piv | peak inverse voltage |
| plstc | plastic |
| PMC | paper, metal cased |
| poly | polystyrene |
| Prec | precision |
| PT | paper tubular |
| PTM | paper or plastic, tubular, molded |
| RHS | round head steel |
| rms | root mean square |
| sec | second |
| Si | silicon |
| S/N | serial number |
| t or T | tera, or $10^{12}$ |
| TD | toroid |
| THS | truss head steel |
| tub. | tubular |
| v or V | volt |
| Var | variable |
| w | watt |
| w/ | with |
| w/o | without |
| WW | wire-wound |

## SPECIAL NOTES AND SYMBOLS

| | |
|---|---|
| X000 | Part first added at this serial number. |
| 000X | Part removed after this serial number. |
| *000-000 | Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, or reworked or checked components. |
| Use 000-000 | Part number indicated is direct replacement. |
| | Internal screwdriver adjustment. |
|  | Front-panel adjustment or connector. |

**FRONT**

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 366-0220-00 | | | 1 | KNOB, INTENSITY, small charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8 x 11/16 inch |
| | 210-0590-00 | | | 1 | NUT, hex, 3/8-32 x 7/16 inch |
| | 210-0840-00 | | | 1 | WASHER, .390 ID x 9/16 inch OD |
| 2 | 366-0220-00 | | | 1 | KNOB, FOCUS, small charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8 x 11/16 inch |
| | 210-0590-00 | | | 1 | NUT, hex, 3/8-32 x 7/16 inch |
| | 210-0840-00 | | | 1 | WASHER, .390 ID x 9/16 inch OD |
| 3 | 366-0254-00 | | | 1 | KNOB, ASTIGMATISM, small charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8-32 x 11/16 inch |
| | 210-0590-00 | | | 1 | NUT, hex, 3/8-32 x 7/16 inch |
| | 210-0840-00 | | | 1 | WASHER, .390 ID x 9/16 inch OD |
| 4 | 366-0220-00 | | | 1 | KNOB, SCALE ILLUM, small charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0012-00 | | | 1 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0590-00 | | | 2 | NUT, hex, 3/8-32 x 7/16 inch |
| | 210-0840-00 | | | 1 | WASHER, .390 ID x 9/16 inch OD |

**FRONT** *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 5 | 366-0117-00 | | | 1 | KNOB, TRIGGERING LEVEL, (A) large charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8 x 11/16 inch |
| | 210-0207-00 | | | 1 | LUG, solder 3/8 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| 6 | 366-0117-00 | | | 1 | KNOB, TRIGGERING LEVEL, (B) large charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8 x 11/16 inch |
| | 210-0207-00 | | | 1 | LUG, solder 3/8 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| 7 | 366-0144-00 | | | 1 | KNOB, TIME/CM, (A) large charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| 8 | 366-0038-00 | | | 1 | KNOB, VARIABLE, (A) small red |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| | 262-0595-00 | 100 | 479 | 1 | SWITCH, TIME/CM, (A) wired |
| | 262-0595-01 | 480 | | 1 | SWITCH, TIME/CM, (A) wired |
| | - - - - - - | | | - | Includes: |
| | 260-0530-00 | | | 1 | SWITCH, TIME/CM, (A) unwired |
| | 352-0061-00 | | | 1 | HOLDER, component |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0004-00 | | | 2 | LOCKWASHER, internal #4 |
| | 210-0406-00 | | | 2 | NUT, hex, 4-40 x 3/16 inch |
| | 211-0008-00 | | | 2 | SCREW, 4-40 x 1/4 inch BHS |
| | 348-0003-00 | | | 1 | GROMMET, rubber 5/16 inch |
| | 376-0014-00 | | | 1 | COUPLING, pot |
| | 384-0288-00 | | | 1 | ROD, extension |
| | 406-0899-00 | | | 1 | BRACKET, switch |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| | 210-0449-00 | | | 2 | NUT, hex, 5-40 x 1/4 inch |
| | - - - - - - | | | - | Mounting Hardware For Capacitor: |
| | 210-0006-00 | | | 3 | LOCKWASHER, internal #6 |
| | 210-0407-00 | | | 3 | NUT, hex, 6-32 x 1/4 inch |
| | 210-0803-00 | | | 1 | WASHER, 6L x 3/8 inch |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0012-00 | | | 2 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0255-00 | | | 1 | LUG, solder, pot |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | - - - - - - | | | - | Mounting Hardware for Miniature Pot: |
| | 210-0046-00 | | | 1 | LOCKWASHER, internal .400 OD x .261 inch ID |
| | 210-0583-00 | | | 1 | NUT, hex, 1/4-32 x 5/16 inch |
| | - - - - - - | | | - | Mounting Hardware For Switch: (not included) |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8 x 11/16 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | 210-0803-00 | | | 2 | WASHER, 6L x 3/8 inch |
| | 210-0804-00 | | | 3 | WASHER, 8S x 3/8 inch |
| | 211-0507-00 | | | 2 | SCREW, 6-32 x 5/16 inch BHS |
| | 212-0004-00 | | | 3 | SCREW, 6-32 x 5/16 inch BHS |

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**FRONT** *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 9 | 366-0160-00 | | | 1 | KNOB, HORIZONTAL DISPLAY, large charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set 6-32 x 3/16 inch HSS |
| 10 | 366-0038-00 | | | 1 | KNOB, SWEEP MAGNIFIER, small red |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set 6-32 x 3/16 inch HSS |
| | 262-0603-00 | | | 1 | SWITCH, HORIZONTAL DISPLAY, front, wired |
| | - - - - - - | | | - | Includes: |
| | 260-0532-00 | | | 1 | SWITCH, HORIZONTAL DISPLAY, front, unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8 x 11/16 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | 262-0604-00 | | | 1 | SWITCH, HORIZONTAL DISPLAY, rear, wired |
| | - - - - - - | | | - | Includes: |
| | 260-0533-00 | | | 1 | SWITCH, HORIZONTAL DISPLAY, rear, unwired |
| | 406-0897-00 | | | 1 | BRACKET, trimmer |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0004-00 | | | 2 | LOCKWASHER, internal #4 |
| | 210-0406-00 | | | 2 | NUT, hex, 4-40 x 3/16 inch |
| | 406-0902-00 | | | 1 | BRACKET, switch mounting |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | 210-0840-00 | | | 1 | WASHER, .390 ID x 9/16 inch OD |
| | - - - - - - | | | - | Mounting Hardware For EACH Capacitor: |
| | 213-0088-00 | | | 2 | SCREW, thread forming 4-40 x 3/16 inch PHS phillips |
| | - - - - - - | | | - | Mounting Hardware: (not included w/switch) |
| | 210-0457-00 | | | 2 | NUT, keps, 6-32 x 5/16 inch |
| | 211-0507-00 | | | 2 | SCREW, 6-32 x 5/16 inch BHS |
| 11 | 366-0144-00 | | | 1 | KNOB, TIME/CM OR DELAY TIME, (B) large charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| 12 | 366-0038-00 | | | 1 | KNOB, VARIABLE, (B) small red |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| | 262-0596-00 | 100 | 479 | 1 | SWITCH, TIME/CM OR DELAY TIME, (B) wired |
| | 262-0596-01 | 480 | | 1 | SWITCH, TIME/CM OR DELAY TIME, (B) wired |
| | - - - - - - | | | - | Includes: |
| | 260-0531-00 | | | 1 | SWITCH, TIME/CM OR DELAY TIME, unwired |
| | 384-0287-00 | | | 1 | ROD, extension |
| | 348-0003-00 | | | 1 | GROMMET, rubber 5/16 inch |
| | 376-0014-00 | | | 1 | COUPLING, pot |
| | 352-0061-00 | | | 1 | HOLDER, component |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0004-00 | | | 2 | LOCKWASHER, internal #4 |
| | 210-0406-00 | | | 2 | NUT, hex, 4-40 x 3/16 inch |
| | 211-0008-00 | | | 2 | SCREW, 4-40 x 1/4 inch BHS |



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**FRONT** *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 12 | 406-0898-00 | | | 1 | BRACKET, switch |
| Cont | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| | 210-0449-00 | | | 2 | NUT, hex, 5-40 x 1/4 inch |
| | - - - - - - | | | - | Mounting Hardware For Capacitor: |
| | 210-0006-00 | | | 1 | LOCKWASHER, internal #6 |
| | 210-0407-00 | | | 1 | NUT, hex, 6-32 x 1/4 inch |
| | 210-0803-00 | | | 1 | WASHER, 6L x 3/8 inch |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0012-00 | | | 2 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0255-00 | | | 1 | LUG, solder pot |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | - - - - - - | | | - | Mounting Hardware For Switch: (not included) |
| | 210-0013-00 | | | 1 | LOCKWASHER, internal 3/8 x 11/16 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | 210-0803-00 | | | 2 | WASHER, 6L x 3/8 inch |
| | 210-0804-00 | | | 3 | WASHER, 8S x 3/8 inch |
| | 211-0507-00 | | | 2 | SCREW, 6-32 x 5/16 inch BHS |
| | 212-0004-00 | | | 2 | SCREW, 8-32 x 5/16 inch BHS |
| | 212-0023-00 | | | 1 | SCREW, 8-32 x 3/8 inch BHS |
| 13 | 366-0159-00 | | | 1 | KNOB, HORIZONTAL POSITION, large charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| 14 | 366-0032-00 | | | 1 | KNOB, VERNIER, small red |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 212-0012-00 | | | 1 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0207-00 | | | 1 | LUG, solder, 3/8 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| 15 | 366-0115-00 | | | 1 | KNOB, AMPLITUDE CALIBRATOR, large charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| | 262-0599-00 | 100 | 199 | 1 | SWITCH, AMPLITUDE CALIBRATOR, wired |
| | 262-0731-00 | 200 | | 1 | SWITCH, AMPLITUDE CALIBRATOR, wired |
| | - - - - - - | | | - | Includes: |
| | 260-0536-00 | | | 1 | SWITCH, AMPLITUDE CALIBRATOR, unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0012-00 | | | 1 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| 16 | 366-0153-00 | | | 1 | KNOB, VAR 10-1, small charcoal |
| | - - - - - - | | | - | Includes: |
| | 213-0004-00 | | | 1 | SCREW, set, 6-32 x 3/16 inch HSS |
| | - - - - - - | | | - | Mounting Hardware For Miniature Pot: |
| | 210-0046-00 | | | 1 | LOCKWASHER, internal .400 OD x .261 inch ID |
| | 210-0583-00 | | | 1 | NUT, hex, 1/4-32 x 5/16 inch |
| | 210-0940-00 | | | 1 | WASHER, 1/4 ID x 3/8 inch OD |
| 17 | 366-0215-00 | 100 | 169 | 4 | KNOB, LEVER, (B) charcoal |
| | 366-0215-01 | 170 | | 4 | KNOB, LEVER, (B) charcoal |
| | 262-0598-00 | | | 1 | SWITCH, TRIGGERING, (B) wired |
| | - - - - - - | | | - | Includes: |
| | 260-0493-00 | | | 1 | SWITCH, MODE lever unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |
| | 260-0494-00 | | | 1 | SWITCH, COUPLING, lever unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |

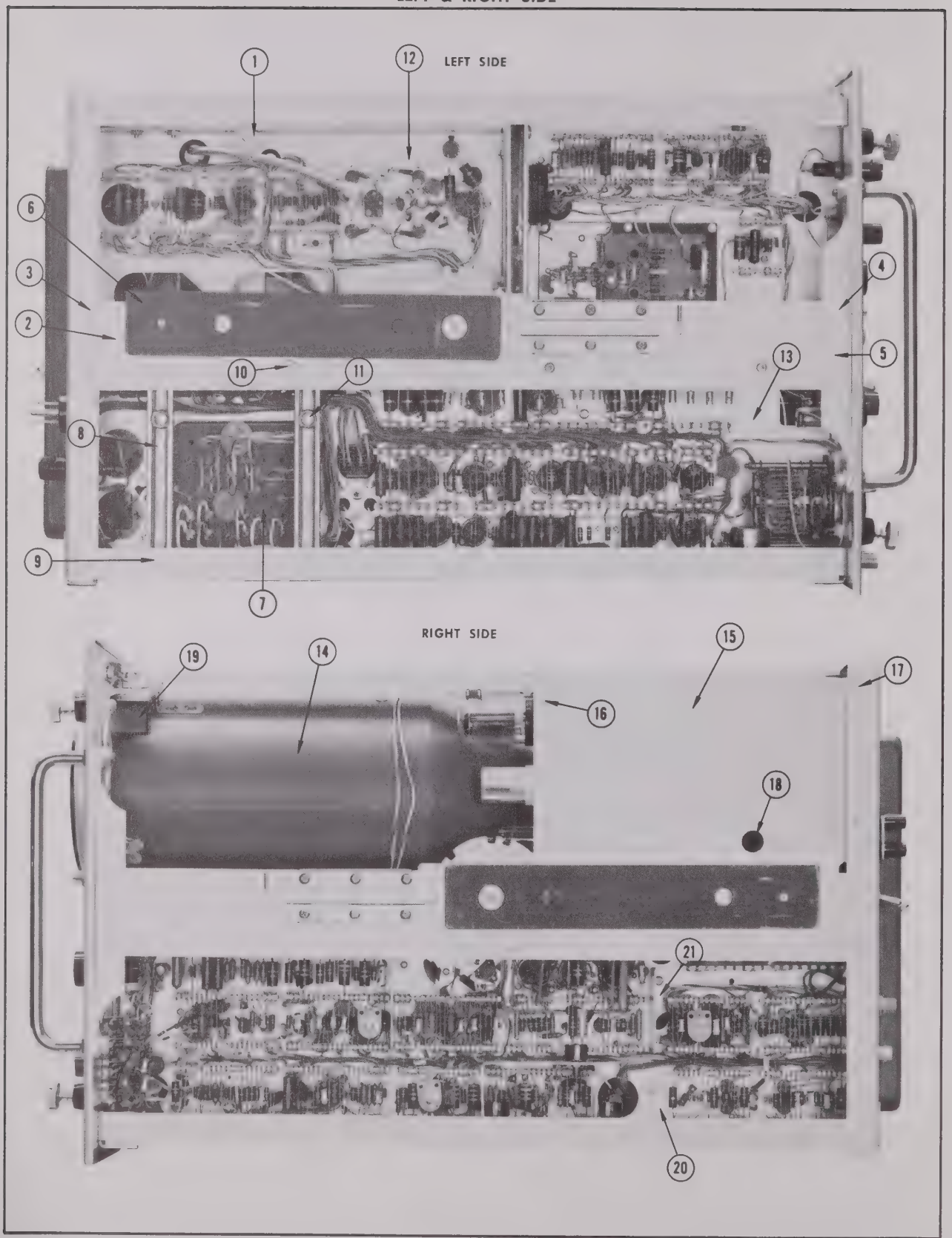
**FRONT** *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 17 | 260-0495-00 | | | 1 | SWITCH, SOURCE, lever unwired |
| Cont. | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |
| | 260-0542-00 | | | 1 | SWITCH, SLOPE, lever unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |
| | 406-0943-00 | | | 1 | BRACKET, lever switch |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0201-00 | | | 1 | LUG, solder SE #4 |
| | 210-0586-00 | | | 4 | NUT, keps, 4-40 x 1/4 inch |
| 18 | 366-0215-00 | 100 | 169 | 4 | KNOB, LEVER, (A) charcoal |
| | 366-0215-01 | 170 | | 4 | KNOB, LEVER, (A) charcoal |
| | 262-0597-00 | 100 | 169 | 1 | SWITCH, TRIGGERING, (A) wired |
| | 262-0692-00 | 170 | | 1 | SWITCH, TRIGGERING, (A) wired |
| | - - - - - - | | | - | Includes: |
| | 260-0493-00 | | | 1 | SWITCH, MODE, lever unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |
| | 260-0494-00 | | | 1 | SWITCH, COUPLING, lever unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |
| | 260-0495-00 | | | 1 | SWITCH, SOURCE, lever unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |
| | 260-0542-00 | | | 1 | SWITCH, SLOPE, lever unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0141-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch PHS phillips |
| | 406-0943-00 | | | 1 | BRACKET, lever switch |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0201-00 | | | 2 | LUG, solder SE #4 |
| | 210-0586-00 | | | 4 | NUT, keps, 4-40 x 1/4 inch |
| 19 | 366-0261-00 | 100 | 169 | 1 | KNOB, BRIGHTNESS, gray delrin |
| | 366-0283-00 | 170 | | 1 | KNOB, BRIGHTNESS, gray delrin |
| | - - - - - - | | | - | Includes: |
| | 214-0395-00 | | | 1 | SPRING, wire |
| 20 | 366-0215-00 | 100 | 169 | 1 | KNOB, SINGLE SWEEP, charcoal |
| | 366-0215-01 | 170 | | 1 | KNOB, SINGLE SWEEP, charcoal |
| | 262-0602-00 | | | 1 | SWITCH, SWEEP NORMAL, wired |
| | - - - - - - | | | - | Includes: |
| | 260-0496-00 | | | 1 | SWITCH, SINGLE SWEEP, unwired |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0586-00 | | | 2 | NUT, keps, 4-40 x 1/4 inch |
| 21 | 331-0091-00 | | | 1 | DIAL, DELAY-TIME MULTIPLIER 1-10 |
| 22 | 200-0575-00 | | | 4 | COVER, cabinet latch |
| | 213-0130-00 | | | 4 | SCREW, captive, panel |
| | 214-0427-00 | | | 4 | SPRING, cabinet latch |
| | 354-0236-00 | 100 | 469 | 4 | RING, retaining |
| | 354-0294-00 | 470 | | 4 | RING, retaining |
| 23 | 367-0041-00 | | | 2 | HANDLE, assembly |
| | - - - - - - | | | - | EACH Includes: |
| | 210-0524-00 | | | 2 | NUT, hex, 5/16-24 x 1/2 inch OD |
| | 210-0807-00 | | | 2 | WASHER, 5/16 ID x 5/8 inch OD |
| | 367-0003-00 | | | 2 | HANDLE |
| | 432-0004-00 | | | 2 | BASE, 3/4 OD x 1/4 inch |

**FRONT** *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 24 | 131-0106-00 | | | 2 | CONNECTOR, chassis mounted, 1 contact, BNC |
| | - - - - - - | | | - | Each Includes: |
| | 210-0012-00 | | | 1 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| 25 | 129-0064-00 | | | 6 | POST, binding |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-0457-00 | | | 1 | NUT, keps, 6-32 x 5/16 inch |
| | 358-0181-00 | | | 1 | BUSHING, nylon, charcoal |
| 26 | 129-0020-00 | | | 2 | POST, binding, assembly |
| | - - - - - - | | | - | Each Consisting Of: |
| | 200-0072-00 | | | 1 | CAP, plated |
| | 355-0503-00 | | | 1 | STEM, adapter |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-0206-00 | | | 1 | LUG, solder SE #10 long |
| | 210-0445-00 | | | 1 | NUT, hex, 10-32 x 3/8 inch |
| 27 | 131-0274-00 | | | 1 | CONNECTOR, chassis mounted, BNC |
| 28 | 214-0335-00 | | | 1 | BOLT, current loop |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0201-00 | | | 2 | LUG, solder SE #4 |
| | 210-0442-00 | | | 2 | NUT, hex, 3-48 x 3/16 inch |
| | 210-0593-00 | | | 2 | NUT, current loop, hex, 5-40 x 1/4 inch |
| | 210-0801-00 | | | 2 | WASHER, 5S x 9/32 inch |
| | 210-0849-00 | | | 2 | WASHER, fiber #4 |
| | 361-0059-00 | | | 1 | SPACER, current loop |
| 29 | 136-0026-00 | | | 1 | SOCKET, light |
| | 378-0518-00 | 100 | 519 | 1 | JEWEL, pilot light, red |
| | 378-0513-00 | 520 | | 1 | JEWEL, pilot light, green |
| 30 | 260-0199-00 | | | 1 | SWITCH, POWER ON, toggle |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0414-00 | | | 1 | NUT, hex, 15/32-32 x 9/16 inch |
| | 210-0473-00 | | | 1 | NUT, switch, 15/32-32 x 5/64 inch |
| | 210-0902-00 | | | 1 | WASHER, .470 ID x 21/32 inch OD |
| | 354-0055-00 | | | 1 | RING, locking switch |
| 31 | 352-0064-00 | | | 3 | HOLDER, neon, double |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-0406-00 | | | 2 | NUT, hex, 4-40 x 3/16 inch |
| | 211-0109-00 | | | 1 | SCREW, 4-40 x 7/8 inch FHS |
| 32 | 352-0067-00 | | | 3 | HOLDER, neon single |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0406-00 | | | 2 | NUT, hex, 4-40 x 3/16 inch |
| | 211-0109-00 | | | 1 | SCREW, 4-40 x 7/8 inch FHS |
| 33 | 200-0382-00 | | | 1 | COVER, graticule |
| | - - - - - - | | | - | Includes: |
| | 354-0116-00 | | | 1 | RING, ornamental |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0424-00 | | | 4 | NUT, knurled, 3/8-24 x 9/16 inch |
| | 355-0043-00 | | | 4 | STUD, 3/8-32 x .897 inch long |
| | 387-0917-00 | 100 | 169 | 1 | PLATE, light reflector (under cover) |
| | 386-0212-00 | 170 | | 1 | PLATE, light reflector (under cover) |
| | 214-0433-00 | 100 | 169 | 1 | SPRING, light reflector (under cover) |
| | 354-0262-00 | 170 | | 1 | RING, light plate reflector |
| 34 | 354-0204-00 | | | 1 | RING, crt shockmount |
| 35 | - - - - - - | | | 1 | FILTER, light (see standard accessories) |
| 36 | 333-0781-00 | | | 1 | PANEL, front |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 212-0039-00 | | | 3 | SCREW, 8-32 x 3/8 inch THS |

## LEFT & RIGHT SIDE



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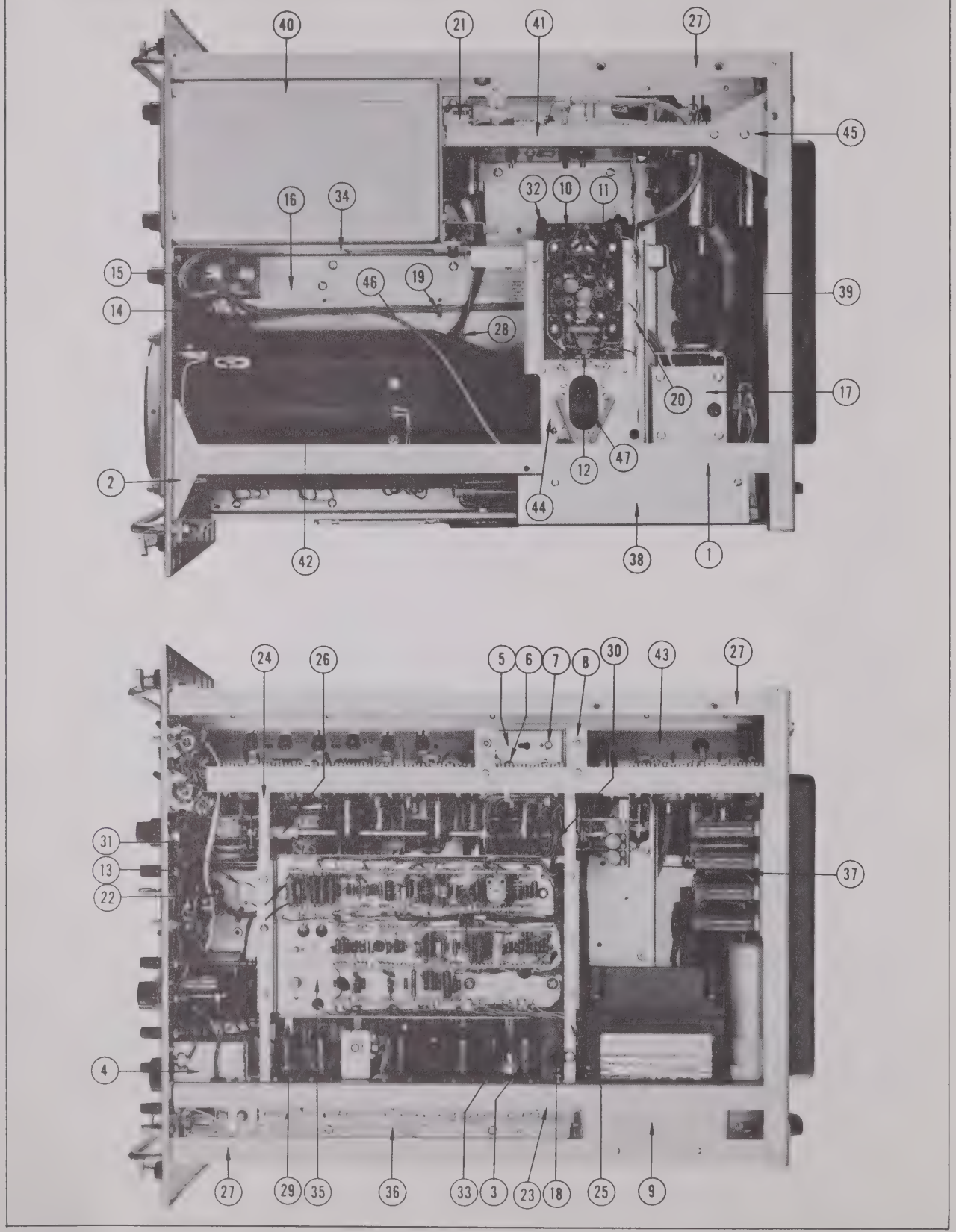
## LEFT & RIGHT SIDE

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 343-0003-00 | | | 3 | CLAMP, cable, 1/4 inch plastic |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-0803-00 | | | 1 | WASHER, 6L x 3/8 x .032 inch |
| | 210-0863-00 | | | 1 | WASHER, "D" type for #10 screw |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, BHS |
| 2 | 351-0075-00 | | | 2 | GUIDE, rail track support |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| 3 | 212-0560-00 | | | 2 | SCREW, 10-32 x 5/16 inch, 100° FHS phillips |
| 4 | 213-0090-00 | | | 2 | SCREW, 10-32 x 1/2 inch, HHS |
| | 361-0071-00 | | | 2 | SPACER, guide rail, 5/16 inch diameter |
| 5 | 122-0119-00 | | | 2 | ANGLE, brace guide rail and power |
| 6 | 351-0007-00 | | | 1 | TRACK, slideout, chassis section (pair) |
| | - - - - - - | | | - | mounting hardware: (not incl w/track) |
| | 212-0023-00 | X170 | | 12 | SCREW, 8-32 x 3/8 inch, BHS |
| 7 | - - - - - - | | | - | Transformer Mounting Hardware: |
| 8 | 381-0221-00 | | | 2 | BAR, transformer support |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-0458-00 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| 9 | 212-0021-00 | | | 2 | SCREW, 8-32 x 1 inch, FHS |
| 10 | 212-0506-00 | | | 1 | SCREW, 10-32 x 3/8 inch, FHS 100° phillips |
| | 210-0010-00 | | | 4 | LOCKWASHER, internal, #10 |
| | 210-0564-00 | | | 2 | NUT, hex, 10-32 x 3/8 x 1/8 inch thick, double chamfered |
| | 210-0812-00 | | | 4 | WASHER, fiber, #10 |
| | 212-0524-00 | | | 4 | SCREW, 10-32 x 3 1/4 inch, HHS |
| 11 | 212-0534-00 | | | 2 | SCREW, 10-32 x 1 inch, BHS |
| | 384-0612-00 | | | 2 | ROD, standoff transformer, 3/8 hex x 2 1/8 inch long |
| 12 | - - - - - - | | | - | LOWER VERTICAL AMPLIFIER (see page 6-30) |
| 13 | - - - - - - | | | - | POWER, (see page 6-16) |
| 14 | - - - - - - | | | - | CATHODE RAY TUBE SHIELD (see page 6-34) |
| 15 | 337-0600-00 | | | 1 | SHIELD, high voltage |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| 16 | 211-0504-00 | | | 4 | SCREW, 6-32 x 1/4 inch, BHS |
| 17 | 211-0508-00 | | | 2 | SCREW, 6-32 x 5/16 inch, FHS 100° phillips |
| 18 | 348-0063-00 | | | 1 | GROMMET, plastic, 1/2 inch |
| 19 | 200-0534-00 | | | 1 | COVER, neon holder |
| 20 | - - - - - - | | | - | SWEEP, (see page 6-20) |
| 21 | 337-0588-00 | | | 1 | SHIELD, sweep generator "A" |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0504-00 | | | 2 | SCREW, 6-32 x 1/4 inch, BHS |

## TOP & BOTTOM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## TOP & BOTTOM

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 122-0109-00 | | | 1 | RAIL, top left |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0458-00 | | | 4 | NUT, keps, 8-32 x 11/32 inch |
| | 212-0040-00 | | | 4 | SCREW, 8-32 x 3/8 inch, 100°, FHS, phillips |
| 2 | 407-0002-00 | | | 1 | BRACKET, angle, rail |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0458-00 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| | 212-0040-00 | | | 3 | SCREW, 8-32 x 3/8 inch, 100°, FHS, phillips |
| 3 | 202-0102-00 | | | 1 | CAN, relay |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0457-00 | | | 2 | NUT, keps, 6-32 x 5/16 inch |
| 4 | 337-0574-00 | | | 1 | SHIELD, calibrator switch |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0457-00 | | | 1 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0803-00 | | | 1 | WASHER, 6L x 3/8 inch |
| | 211-0504-00 | | | 1 | SCREW, 6-32 x 1/4 inch BHS |
| 5 | 337-0570-00 | | | 1 | SHIELD, horizontal preamplifier |
| | - - - - - - | | | - | Mounting Hardware (not included) |
| | 211-0504-00 | | | 2 | SCREW, 6-32 x 1/4 inch BHS |
| 6 | 348-0031-00 | | | 1 | GROMMET, snap-in |
| 7 | - - - - - - | | | - | Mounting Hardware For Pot: |
| | 210-0583-00 | | | 1 | NUT, hex, 1/4-32 x 5/16 inch |
| | 210-0940-00 | | | 1 | WASHER, 1/4 ID x 3/8 inch OD |
| 8 | - - - - - - | | | - | Mounting Hardware For EACH Pot: |
| | 210-0046-00 | 100 | 539 | 1 | LOCKWASHER, internal .261 ID x .400 inch OD |
| | 210-0940-00 | 540 | | 1 | WASHER, 1/4 ID x 3/8 inch OD |
| | 210-0471-00 | | | 1 | NUT, hex, 1/4-32 x 5/16 inch |
| | 358-0054-00 | | | 1 | BUSHING, banana jack |
| 9 | 407-0022-00 | | | 1 | BRACKET, transformer |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 212-0004-00 | | | 2 | SCREW, 8-32 x 5/16 inch BHS |
| 10 | 670-0401-00 | | | 1 | BOARD, circuit, upper vertical amplifier |
| | - - - - - - | | | - | Includes: |
| 11 | 136-0150-00 | 100 | 169 | 6 | SOCKET, 3 pin, transistor |
| | 136-0183-00 | 170 | | 6 | SOCKET, 3 pin, transistor |
| 12 | 343-0088-00 | | | 1 | CLAMP, cable, small |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0801-00 | | | 4 | WASHER, 5S x 9/32 inch |
| | 211-0507-00 | | | 4 | SCREW, 6-32 x 5/16 inch BHS |
| 13 | 385-0170-00 | | | 1 | ROD, delrin 5/16 x 1 1/8 inch long |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0068-00 | | | 1 | SCREW, thread forming, 6-32 x 5/16 inch FHS CSK 100° phillips |
| 14 | 387-0858-00 | | | 1 | PLATE, sub-panel, front |
| 15 | 200-0269-00 | | | 2 | COVER, pot |

## TOP & BOTTOM *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 16 | 387-0759-00 | | | 1 | PLATE, vertical bulkhead |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0458-00 | | | 4 | NUT, keps, 8-32 x 11/32 inch |
| | 210-0804-00 | | | 5 | WASHER, 8S x 3/8 inch |
| | 212-0001-00 | | | 3 | SCREW, 8-32 x 1/4 inch BHS |
| | 212-0004-00 | | | 2 | SCREW, 8-32 x 5/16 inch BHS |
| | 212-0040-00 | | | 4 | SCREW, 8-32 x 3/8 inch FHS, phillips |
| 17 | 406-0995-00 | | | 1 | BRACKET support |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0458-00 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| | 210-0804-00 | | | 2 | SCREW, 8-32 x 1/4 inch BHS |
| | 212-0001-00 | | | 4 | WASHER, 8S x 3/8 inch |
| 18 | 381-0215-00 | | | 1 | BAR, stop |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 212-0008-00 | | | 1 | SCREW, 8-32 x 1/2 inch BHS |
| 19 | 343-0089-00 | 100 | 469 | 12 | CLAMP, cable, large |
| | 343-0089-00 | 470 | | 11 | CLAMP, cable, large |
| 20 | 343-0088-00 | | | 3 | CLAMP, cable, small |
| 21 | 366-0271-00 | | | 1 | KNOB, COMPENSATION |
| | 260-0601-00 | | | 1 | SWITCH, COMPENSATION, slide |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0504-00 | | | 2 | SCREW, 6-32 x 1/4 inch BHS |
| 22 | 358-0166-00 | | | 2 | BUSHING, plastic, black |
| 23 | 348-0006-00 | | | 1 | GROMMET, rubber 3/4 inch (not shown) |
| 24 | 384-0613-00 | | | 1 | ROD, anchor |
| | - - - - - - | | | - | Includes: |
| | 134-0033-00 | | | 2 | PLUG, banana, push in type |
| | 214-0370-00 | | | 1 | PIN, locating |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0804-00 | | | 2 | WASHER, 8S x 3/8 inch |
| | 212-0004-00 | | | 2 | SCREW, 8-32 x 5/16 inch BHS |
| 25 | 384-0614-00 | | | 1 | ROD, chassis hinge |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 212-0010-00 | | | 1 | SCREW, 8-32 x 5/8 inch BHS |
| | 358-0237-00 | | | 1 | BUSHING, hinge pin |
| | 361-0052-00 | | | 1 | SPACER, hinge pin |
| 26 | 376-0007-00 | | | 1 | COUPLING |
| | - - - - - - | | | - | Includes: |
| | 213-0005-00 | | | 2 | SCREW, set, 8-32 x 1/8 inch HSS |
| 27 | 122-0120-00 | | | 3 | ANGLE, rail, corner |
| | - - - - - - | | | - | Mounting Hardware For Each: (not included) |
| | 210-0458-00 | | | 3 | NUT, keps 8-32 x 11/32 inch |
| | 212-0039-00 | | | 1 | SCREW, 8-32 x 3/8 inch THS phillips |
| | 212-0040-00 | | | 3 | SCREW, 8-32 x 3/8 inch FHS |
| 28 | 385-0134-00 | | | 3 | ROD, delrin |
| | - - - - - - | | | - | Mounting Hardware For Each: (not included) |
| | 213-0104-00 | | | 1 | SCREW, thread forming, 6-32 x 3/8 inch THS phillips |
| 29 | 337-0008-00 | | | 1 | SHIELD, tube |
| 30 | 343-0003-00 | | | 1 | CLAMP, cable 1/4 inch |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0863-00 | | | 1 | WASHER, "D" type #10 |
| | 212-0008-00 | | | 1 | SCREW, 8-32 x 5/8 inch BHS |
| 31 | 344-0047-00 | | | 1 | CLIP, deflection plate |



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## TOP & BOTTOM *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 32 | 119-0030-00 | | | 1 | DELAY LINE, assembly |
| | - - - - - - | | | - | Includes: |
| | 131-0271-00 | | | 2 | CONNECTOR, right hand |
| | 200-0482-00 | 100 | 679 | 1 | COVER, delay line housing |
| | 200-0482-02 | 680 | | 1 | COVER, delay line housing |
| | 210-0201-00 | | | 1 | LUG, solder SE4 |
| | 210-0406-00 | | | 3 | NUT, hex, 4-40 x 3/16 inch |
| | 210-0407-00 | | | 7 | NUT, hex, 6-32 x 1/4 inch |
| | 211-0011-00 | | | 1 | SCREW, 4-40 x 5/16 inch BHS |
| | 211-0517-00 | | | 4 | SCREW, 6-32 x 1 inch BHS |
| | 380-0049-00 | | | 1 | HOUSING, delay line |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0457-00 | | | 4 | NUT, keps, 6-32 x 5/16 inch |
| 33 | 337-0648-00 | | | 1 | SHIELD, heat dissipating (not shown) |
| 34 | 387-0932-00 | | | 1 | PLATE, bulkhead support |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0457-00 | | | 3 | NUT, keps 8-32 x 5/16 inch |
| | 210-0804-00 | | | 5 | WASHER, 8S x 3/8 inch |
| | 211-0559-00 | | | 3 | SCREW, 6-32 x 3/8 inch FHS, 100° |
| | 212-0004-00 | | | 5 | SCREW, 8-32 x 5/16 inch BHS |
| 35 | - - - - - - | | | - | DELAY SWEEP (see page 6-24) |
| 36 | - - - - - - | | | - | POWER (see page 6-16) |
| 37 | - - - - - - | | | - | SHUNT BRACKET (see page 6-23) |
| 38 | - - - - - - | | | - | FOCUS AND INTENSITY (see page 6-26) |
| 39 | - - - - - - | | | - | FAN (see page 6-23) |
| 40 | - - - - - - | | | - | PLUG-IN HOUSING (see page 6-19) |
| 41 | - - - - - - | | | - | LOWER VERTICAL AMPLIFIER (see page 6-32) |
| 42 | - - - - - - | | | - | CRT SHIELD AND BRACKET (see page 6-36) |
| 43 | - - - - - - | | | - | SWEEP (see page 6-20) |
| 44 | - - - - - - | | | - | UPPER VERTICAL AMPLIFIER (see page 6-27) |
| 45 | - - - - - - | | | - | BRACKET, lower vertical amplifier (see page 6-32) |
| 46 | 131-0350-00 | | | 1 | CONNECTOR, anode, assembly |
| | - - - - - - | | | - | connector includes: |
| | 200-0110-00 | | | 1 | COVER, anode lead |
| | 214-0357-00 | | | 1 | SPRING, anode |
| | 432-0046-00 | | | 1 | BASE, anode |
| 47 | 131-0353-00 | | | 1 | CONNECTOR, deflection lead, brown |
| | 131-0354-00 | | | 1 | CONNECTOR, deflection lead, blue |
| | 175-0587-00 | | | 1 | WIRE, CRT lead, .500 foot, striped red, w/connector |
| | 175-0588-00 | | | 1 | WIRE, CRT lead,.833 foot, striped orange, w/connector |
| | 175-0592-00 | | | 1 | WIRE, CRT lead,.960 foot, striped green, w/connector |

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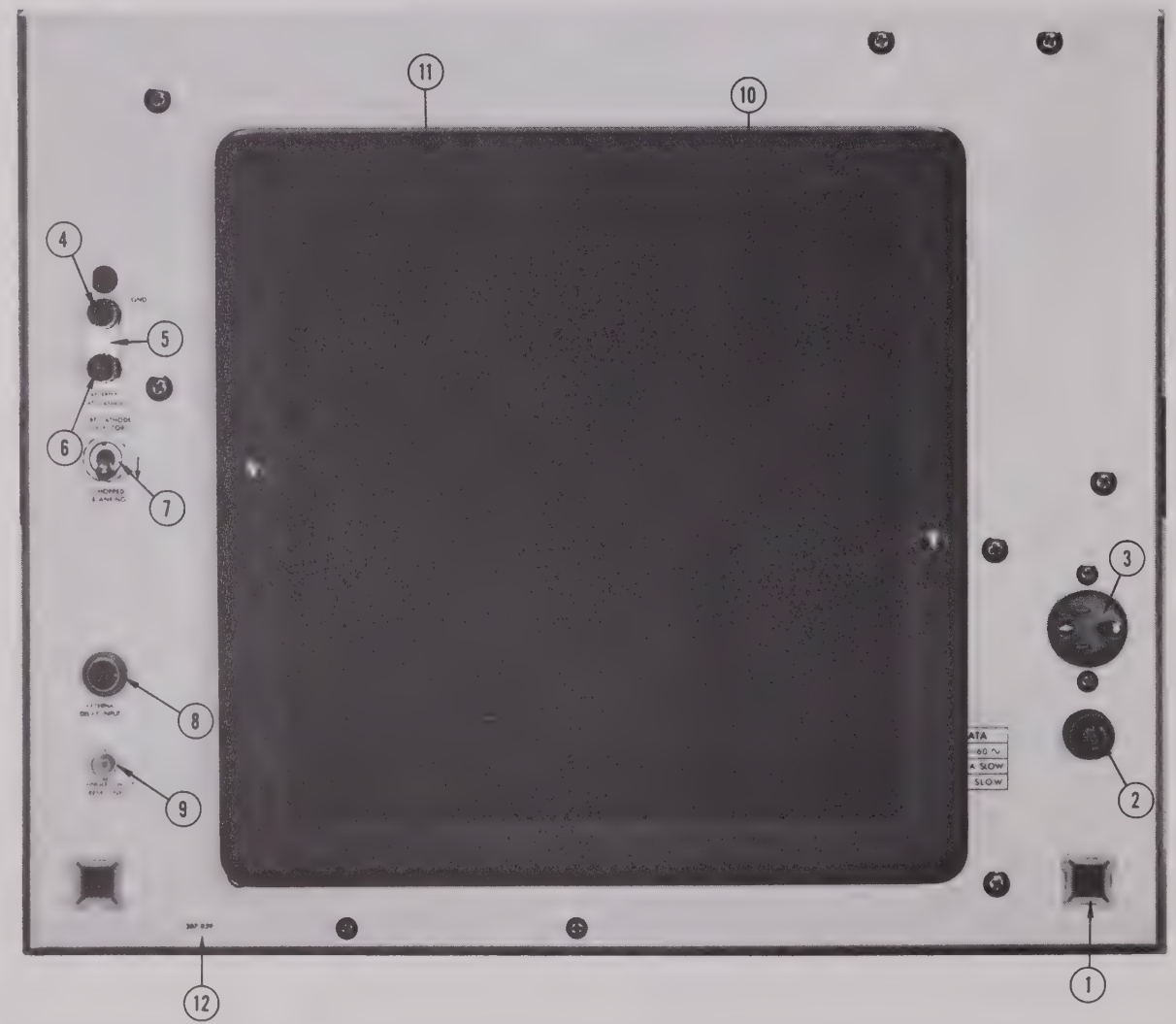




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## REAR

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 358-0236-00 | | | 2 | BUSHING, guide |
| 2 | 352-0002-00 | | | 1 | HOLDER, fuse assembly 3 AG |
| | - - - - - - | | | - | Consisting Of: |
| | 200-0582-00 | | | 1 | CAP, fuse |
| | 210-0873-00 | | | 1 | WASHER, rubber, 1/2 ID x 11/16 inch OD |
| | 352-0010-00 | | | 1 | HOLDER, fuse 3AG |
| | - - - - - - | | | 1 | NUT, fuse holder |
| 3 | 131-0102-00 | 100 | 469 | 1 | CONNECTOR, tek motor base, 3 wire |
| | 131-0102-01 | 470 | | 1 | CONNECTOR, tek motor base, 3 wire |
| | - - - - - - | | | - | assembly includes: |
| | 129-0041-00 | 100 | 469 | 1 | POST, ground |
| | 129-0041-01 | 470 | | 1 | POST, ground |
| | 200-0185-00 | 100 | 469 | 1 | COVER, plastic |
| | 200-0185-01 | 470 | | 1 | COVER, plastic |
| | 210-0003-00 | 100 | 469X | 2 | LOCKWASHER, external, #4 |
| | 210-0551-00 | 100 | 469X | 12 | NUT, hex., 4-40 x 1/4 inch |
| | 211-0132-00 | X470 | | 1 | SCREW, sems, 4-40 x 1/2 inch, PHS |
| | 211-0015-00 | 100 | 469 | 1 | SCREW, 4-40 x 1/2 inch, RHS |
| | 213-0088-00 | 470 | | 1 | SCREW, thread forming, 4-40 x 1/4 inch, PHS |
| | 214-0078-00 | | | 2 | PIN, connecting |
| | 377-0041-00 | 100 | 469 | 1 | INSERT, plastic |
| | 377-0051-00 | 470 | | 1 | INSERT, plastic |
| | 386-0933-00 | | | 1 | PLATE, mounting |
| 4 | 129-0064-00 | | | 1 | POST, binding |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0457-00 | | | 1 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0940-00 | | | 1 | WASHER, 1/4 ID x 3/8 inch OD |
| 5 | 346-0027-00 | | | 1 | STRAP, ground |
| 6 | 129-0064-00 | | | 1 | POST, binding |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 358-0181-00 | | | 1 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0457-00 | | | 1 | BUSHING, nylon, charcoal |
| 7 | 260-0209-00 | | | 1 | SWITCH, CRT CATHODE SELECTOR, toggle |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0414-00 | | | 1 | NUT, hex., 15/32-32 x 9/16 inch |
| | 210-0473-00 | | | 1 | NUT, switch, 15/32-32 x 5/64 inch |
| | 210-0902-00 | | | 1 | WASHER, .470 ID x 21/32 inch OD |
| 8 | 131-0206-00 | | | 1 | CONNECTOR, EXTERNAL DELAY INPUT |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0021-00 | | | 1 | LOCKWASHER, internal |
| | 210-0260-00 | | | 1 | LUG, solder, 11/16 inch long |
| | 210-0559-00 | | | 1 | NUT, hex., 7/16-28 x 9/16 inch |
| 9 | 131-0106-00 | | | 1 | CONNECTOR, chassis mounted, 1 contact, BNC |
| | - - - - - - | | | - | Includes: |
| | 210-0012-00 | | | 1 | LOCKWASHER, internal, 3/8 x 1/2 inch |
| | 210-0413-00 | | | 1 | NUT, hex., 3/8-32 x 1/2 inch |
| 10 | 378-0023-00 | | | 1 | FILTER, air foam |
| | 378-0762-00 | | | 1 | SCREEN, filter |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0104-00 | | | 4 | SCREW, thread forming, 6-32 x 3/8 inch THS |
| 11 | 380-0018-00 | | | 1 | HOUSING, air filter |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0402-00 | | | 2 | NUT, cap, hex., 8-32 x 5/16 inch |
| | 210-0458-00 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| | 210-0894-00 | | | 2 | WASHER, polyethylene, .190 ID x 7/16 inch OD |
| | 212-0031-00 | | | 2 | SCREW, 8-32 x 1 1/4 inch RHS |
| 12 | 387-0859-00 | | | 1 | PLATE, sub-panel, rear |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0458-00 | | | 8 | NUT, keps, 8-32 x 11/32 inch |
| | 212-0039-00 | | | 2 | SCREW, 8-32 x 3/8 inch THS |
| | 212-0040-00 | | | 8 | SCREW, 8-32 x 3/8 inch, 100° FHS |

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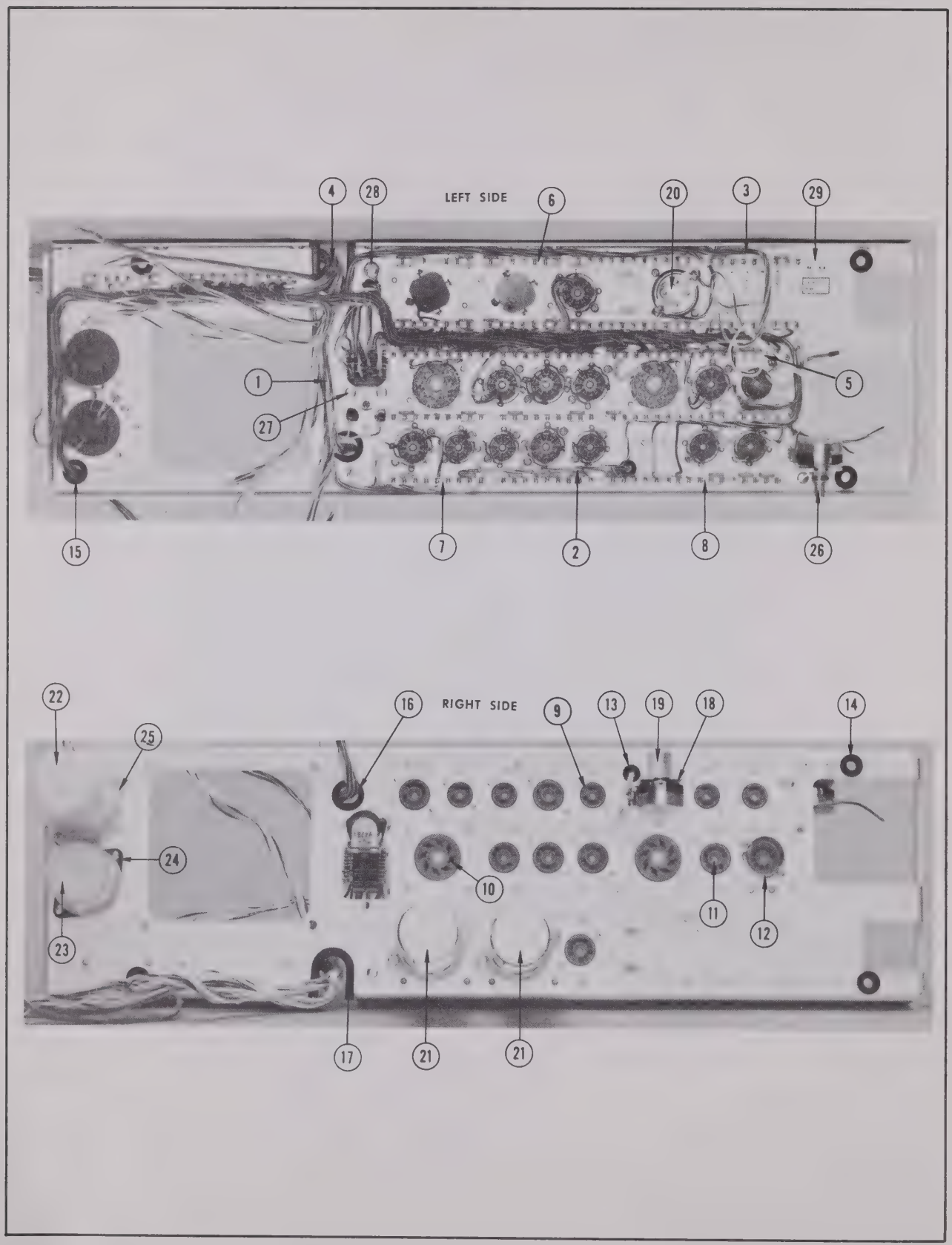
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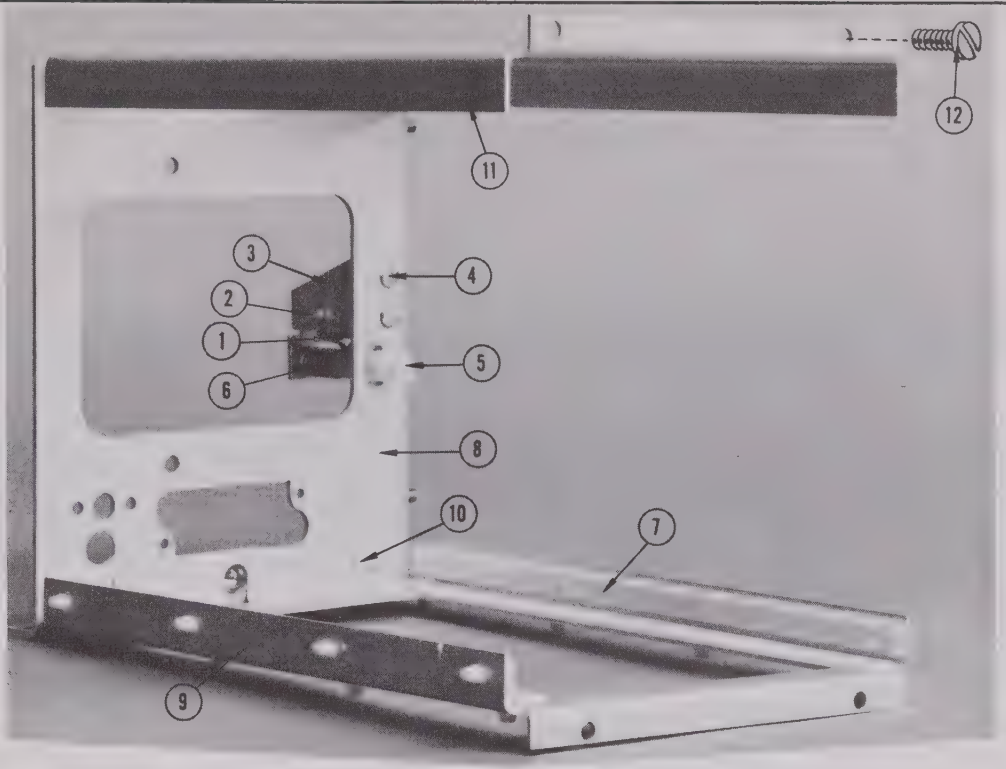
## POWER

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 179-0761-00 | | | 1 | CABLE, harness, power |
| 2 | 179-0764-00 | 100 | 519 | 1 | CABLE, harness, 150 V adj. |
| | 179-0764-01 | 520 | | 1 | CABLE, harness, 150 V adj. |
| 3 | 179-0765-00 | | | 1 | CABLE, harness, 110 V |
| 4 | 179-0771-00 | | | 1 | CABLE, harness, interconnecting |
| 5 | 124-0088-00 | | | 3 | STRIP, ceramic 3/4 inch x 4 notch |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0009-00 | | | 2 | SPACER, nylon |
| 6 | 124-0089-00 | | | 5 | STRIP, ceramic 3/4 inch x 7 notch |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0009-00 | | | 2 | SPACER, nylon |
| 7 | 124-0090-00 | | | 8 | STRIP, ceramtic 3/4 inch x 9 notch |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0009-00 | | | 2 | SPACER, nylon |
| 8 | 124-0091-00 | | | 6 | STRIP, ceramic 3/4 inch x 11 notches |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0009-00 | | | 2 | SPACER, nylon |
| 9 | 136-0008-00 | | | 5 | SOCKET, STM7G |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread forming 5-32 x 3/16 inch PHS |
| 10 | 136-0013-00 | | | 2 | SOCKET, STM8 |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| | 210-0407-00 | | | 2 | NUT, hex 6-32 x 1/4 inch |
| 11 | 136-0015-00 | | | 7 | SOCKET, STM9G |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread forming 5-32 x 3/16 inch PHS |
| 12 | 136-0022-00 | | | 1 | SOCKET, STM9 shield |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread forming 5-32 x 3/16 inch PHS |
| 13 | 348-0003-00 | | | 1 | GROMMET, rubber 5/16 inch |
| 14 | 348-0004-00 | | | 3 | GROMMET, rubber 3/8 inch |
| 15 | 348-0005-00 | | | 1 | GROMMET, rubber 1/2 inch |
| 16 | 348-0012-00 | | | 1 | GROMMET, rubber 5/8 inch |
| 17 | 358-0166-00 | | | 1 | BUSHING, plastic, black |
| 18 | 406-0023-00 | | | 2 | BRACKET, pot |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| | 210-0407-00 | | | 2 | NUT, hex 6-32 x 1/4 inch |
| | 211-0507-00 | | | 2 | SCREW, 6-32 x 5/16 inch BHS |
| 19 | - - - - - - | | | - | Pot Mounting Hardware: |
| | 210-0012-00 | | | 1 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0444-00 | | | 1 | NUT, hex 3/8-32 x 1/2 x 5/8 inch |
| | 210-0840-00 | | | 1 | WASHER, .390 ID x 9/16 inch OD |
| 20 | - - - - - - | | | - | Mounting Hardware For Thermal Cutout: |
| | 213-0044-00 | | | 2 | SCREW, thread forming, 5-32 x 3/16 inch PHS |
| 21 | - - - - - - | | | - | Capacitor Mounting Hardware: |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| | 210-0407-00 | | | 2 | NUT, hex 6-32 x 1/4 inch |
| | 211-0588-00 | | | 2 | SCREW, 6-32 x 3/4 inch HSS |
| | 386-0255-00 | | | 1 | PLATE, metal large |
| | 432-0048-00 | | | 1 | BASE, large |
| 22 | 200-0259-00 | | | 1 | COVER, capacitor polyethylene 3 9/16 x 1.365 inch diameter |

**POWER** *(Cont'd.)*

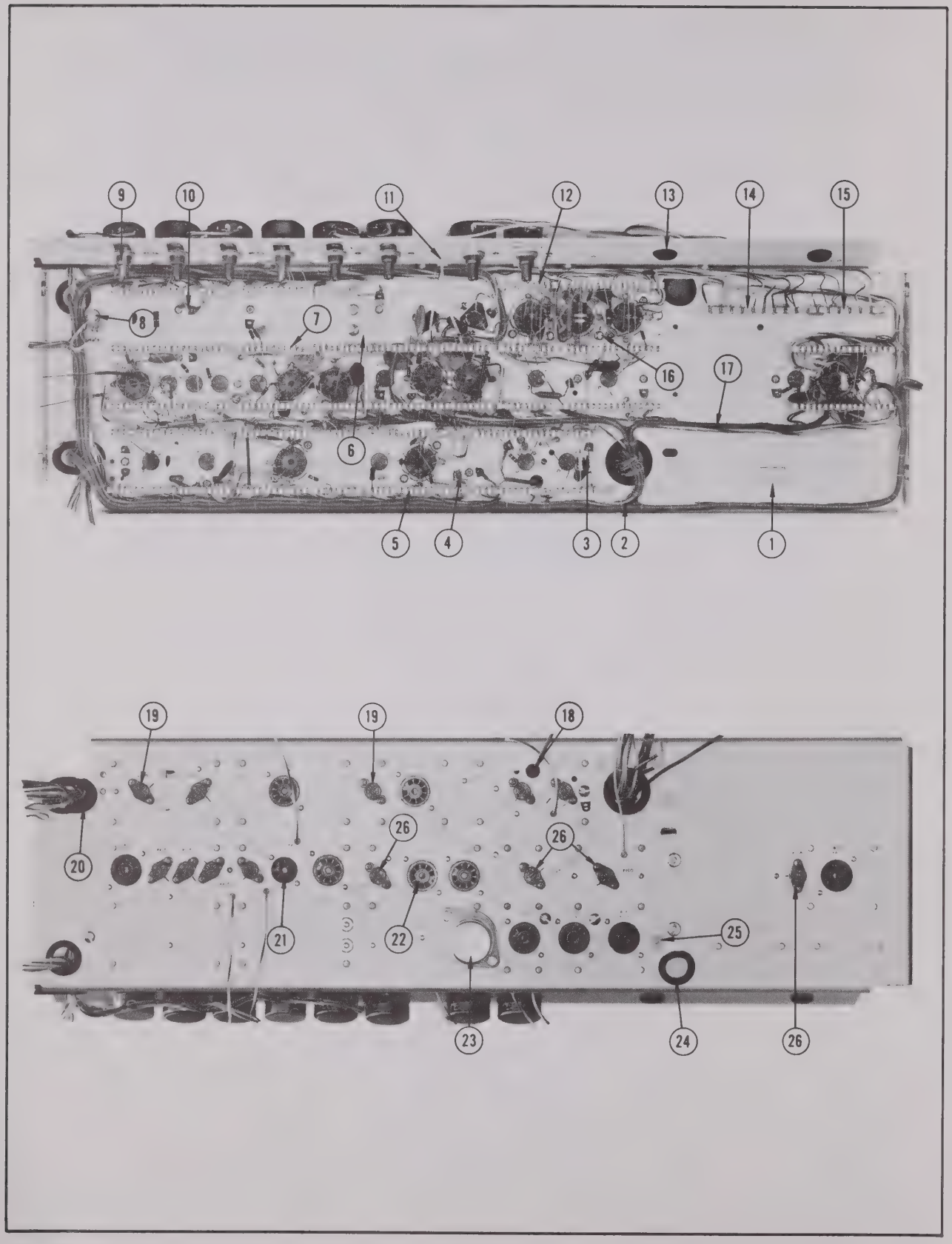
| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 23 | 200-260 | | | 1 | COVER, capacitor polyethylene $2\frac{1}{32}$ x 1.365 inch diameter |
| 24 | 386-254 | | | 1 | PLATE, fiber large |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 210-006 | | | 2 | LOCKWASHER, internal #6 |
| | 210-407 | | | 2 | NUT, hex 6-32 x $\frac{1}{4}$ inch |
| | 211-543 | | | 2 | SCREW, 6-32 x $\frac{5}{16}$ inch RHS |
| 25 | - - - - | | | - | Capacitor Mounting Hardware: |
| | 210-006 | | | 2 | LOCKWASHER, internal #6 |
| | 210-407 | | | 2 | NUT, hex 6-32 x $\frac{1}{4}$ inch |
| | 211-588 | | | 2 | SCREW, 6-32 x $\frac{3}{4}$ inch HSS |
| | 386-254 | | | 1 | PLATE, fiber large |
| | 432-048 | | | 1 | BASE, large |
| 26 | - - - - | | | - | Pot Mounting Hardware: |
| | 210-012 | | | 1 | LOCKWASHER, internal $\frac{3}{8}$ x $\frac{1}{2}$ inch |
| | 210-444 | | | 1 | NUT, hex $\frac{3}{8}$-32 x $\frac{1}{2}$ inch |
| | 210-840 | | | 1 | WASHER, .390 ID x $\frac{9}{16}$ inch OD |
| 27 | - - - - | | | - | Relay Mounting Hardware: |
| | 211-503 | | | 2 | SCREW, 6-32 x $\frac{3}{16}$ inch BHS |
| 28 | - - - - | | | - | Resistor Mounting Hardware 5 watt: |
| | 210-478 | | | 1 | NUT, hex $\frac{5}{16}$ x $\frac{21}{32}$ inch long |
| | 211-507 | | | 1 | SCREW, 6-32 x $\frac{5}{16}$ inch BHS |
| | 211-544 | | | 1 | SCREW, 6-32 x $\frac{3}{4}$ inch THS phillips |
| 29 | 441-478 | | | 1 | CHASSIS, POWER |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 210-458 | | | 5 | NUT, keps 8-32 x $\frac{11}{32}$ inch |
| | 210-804 | | | 7 | WASHER, 8S x $\frac{3}{8}$ inch |
| | 212-001 | | | 7 | SCREW, 8-32 x $\frac{1}{4}$ inch BHS |
| | 212-040 | | | 5 | SCREW, 8-32 x $\frac{3}{8}$ inch 100° FHS phillips |

## PLUG-IN HOUSING




| REF. NO. | PART NO. | SERIAL/MODEL NO. DISC. | SERIAL/MODEL NO. EFF. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 260-516 | | | 1 | SWITCH, push, unwired |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 210-001 | | | 2 | LOCKWASHER, internal #2 |
| 2 | 210-405 | | | 2 | NUT, hex, 2-56 x 3/16 inch |
| | 211-034 | | | 2 | SCREW, 2-56 x 1/2 inch RHS |
| 3 | 406-903 | | | 1 | BRACKET, push switch mounting |
| | - - - - | | | - | Mounting Hardware: (not included) |
| 4 | 211-510 | | | 2 | SCREW, 6-32 x 3/8 inch BHS |
| 5 | 384-270 | | | 1 | ROD, push switch, delrin |
| 6 | 214-333 | | | 1 | SPRING, push switch rod |
| 7 | 351-058 | | | 4 | GUIDE, shoe 8 7/8 inch long |
| 8 | 387-855 | | | 1 | PLATE, back 3/4 x 5 5/8 inch aluminum |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 212-004 | | | 2 | SCREW, 8-32 x 5/16 inch BHS |
| 9 | 387-755 | | | 1 | PLATE, bottom, 5/8 x 5.688 x 9.125 inch aluminum |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 210-205 | | | 1 | LUG, solder SE #8 |
| | 210-458 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| 10 | 212-023 | | | 2 | SCREW, 8-32 x 3/8 inch BHS |
| 11 | 387-857 | | | 1 | PLATE, top, 5/8 x 5 15/32 x 9 7/64 inch aluminum |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 210-458 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| | 212-023 | | | 2 | SCREW, 8-32 x 3/8 inch BHS |
| 12 | - - - - | | | - | Mounting Hardware For Plug-In: (not included) |
| | 210-458 | | | 2 | NUT, keps, 8-32 x 11/32 inch |
| | 212-004 | | | 2 | SCREW, 8-32 x 5/16 inch BHS |
| | 212-040 | | | 2 | SCREW, 8-32 x 3/8 inch 100° FHS phillips slotted |
| | 344-097 | | | 2 | CLIP, grounding 21/32 x 1 11/32 x 1 13/32 inch |

## SWEEP



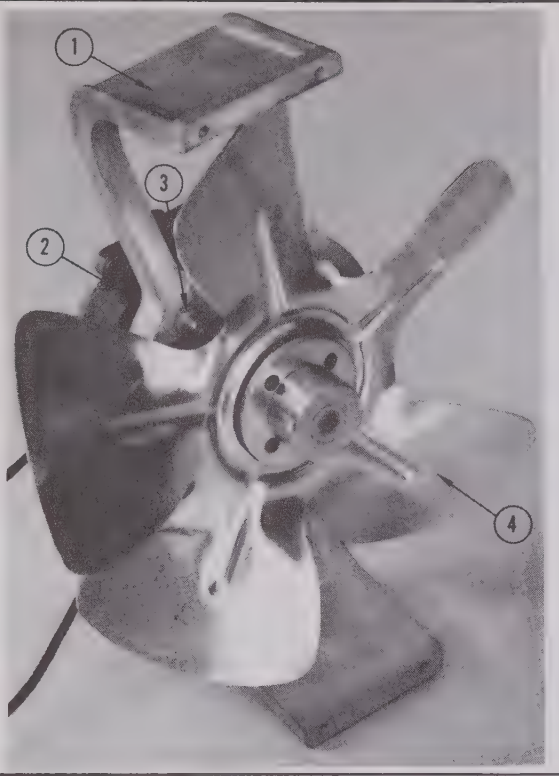
## SWEEP

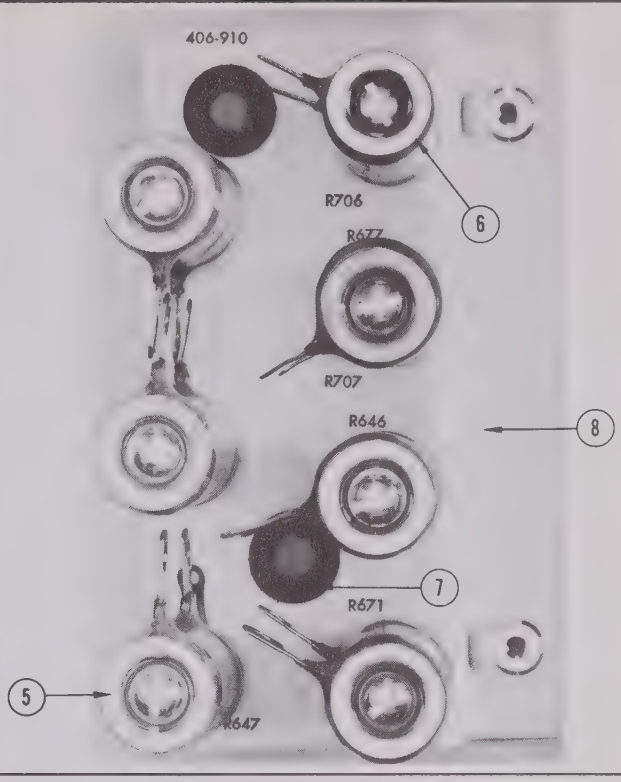
| REF. NO. | PART NO. | SERIAL/MODEL NO. DISC. | SERIAL/MODEL NO. EFF. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 441-514 | | | 1 | CHASSIS |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 212-004 | | | 8 | SCREW, 8-32 x 5/16 inch BHS |
| | 212-040 | | | 4 | SCREW, 8-32 x 3/8 inch 100° FHS |
| 2 | 179-804 | | | 1 | CABLE, harness |
| 3 | 210-202 | | | 2 | LUG, solder #6 |
| | - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 210-407 | | | 1 | NUT, hex 6-32 x 1/4 inch |
| | 211-507 | | | 1 | SCREW, 6-32 x 5/16 inch BHS |
| 4 | 210-204 | | | 4 | LUG, solder DE #6 |
| | - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-044 | | | 1 | SCREW, thread forming, 5-32 x 3/16 inch PHS phillips |
| 5 | 124-155 | | | 7 | STRIP, ceramic 7/16 inch x 16 notches |
| | - - - - | | | - | EACH Includes: |
| | 355-082 | | | 2 | STUD, nylon |
| | - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-039 | | | 2 | SPACER, nylon |
| 6 | 337-588 | | | 1 | SHIELD, sweep generator "A" |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 210-803 | | | 2 | WASHER, 6L x 3/8 inch flat |
| | 211-507 | | | 2 | SCREW, 6-32 x 5/16 inch BHS |
| 7 | 124-154 | | | 13 | STRIP, ceramic 7/16 inch x 20 notches |
| | - - - - | | | - | EACH Includes: |
| | 355-082 | | | 2 | STUD, nylon |
| | - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-039 | | | 2 | SPACER, nylon |
| 8 | - - - - | | | - | Resistor Mounting Hardware 5 watt: |
| | 210-478 | | | 1 | NUT, hex 5/16 x 21/32 inch long |
| | 211-507 | | | 1 | SCREW, 6-32 x 5/16 inch BHS |
| | 211-544 | | | 1 | SCREW, 6-32 x 3/4 inch THS phillips |
| 9 | - - - - | | | - | Pot Mounting Hardware: |
| | 210-012 | | | 1 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-207 | | | 1 | LUG, solder 3/8 inch |
| | 210-413 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | 210-840 | | | 1 | WASHER, .390 ID x 9/16 inch OD |
| 10 | 210-201 | | | 8 | LUG, solder SE #4 |
| | - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-044 | | | 1 | SCREW, thread forming, 5-32 x 3/16 inch PHS phillips |
| 11 | 348-031 | | | 11 | GROMMET, polypropylene 1/4 inch diameter |
| 12 | 124-157 | | | 3 | STRIP, ceramic 7/16 inch x 9 notches |
| | - - - - | | | - | EACH Includes: |
| | 355-082 | | | 2 | STUD, nylon |
| | - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-039 | | | 2 | SPACER, nylon |
| 13 | 348-005 | | | 2 | GROMMET, rubber, 1/2 inch |
| 14 | 124-095 | | | 1 | STRIP, ceramic 7/16 inch x 9 notches |
| | - - - - | | | - | EACH Includes: |
| | 355-046 | | | 2 | STUD, nylon |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 361-009 | | | 2 | SPACER, nylon |
| 15 | 124-094 | | | 1 | STRIP, ceramic 7/16 inch x 7 notches |
| | - - - - | | | - | EACH Includes: |
| | 355-046 | | | 2 | STUD, nylon |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 361-009 | | | 2 | SPACER, nylon |
| 16 | 384-542 | | | 2 | ROD, trimmer mounting |
| | - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 211-507 | | | 1 | SCREW, 6-32 x 5/16 inch BHS |
| 17 | 179-892 | | | 1 | CABLE, harness |
| 18 | 348-002 | | | 1 | GROMMET, rubber 1/4 inch |

**SWEEP** *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. | | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| | | EFF. | DISC. | | |
| 19 | 136-0095-00 | 100 | 169 | 9 | SOCKET, 4 pin transistor |
| | 136-0181-00 | 170 | | 9 | SOCKET, 3 pin transistor |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0113-00 | 100 | 169 | 2 | SCREW, thread forming, 2-32 x 5/16 inch RHS phillips |
| | 354-0234-00 | 170 | | 1 | RING, locking, transistor socket |
| 20 | 348-0051-00 | | | 2 | GROMMET, rubber 15/16 inch |
| 21 | 136-0008-00 | | | 1 | SOCKET, STM7G |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread forming, 5-32 x 3/16 inch PHS phillips |
| 22 | 136-0015-00 | | | 10 | SOCKET, STM9G |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread forming 5-32 x 3/16 inch PHS phillips |
| 23 | 386-0253-00 | | | 1 | PLATE, metal, small |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal #6 |
| | 210-0407-00 | | | 2 | NUT, hex, 6-32 x 1/4 inch |
| | 211-0534-00 | | | 2 | SCREW, 6-32 x 5/16 inch PHS with lockwasher |
| 24 | 348-0006-00 | | | 2 | GROMMET, rubber 3/4 inch |
| 25 | 385-0170-00 | | | 1 | ROD, nylon 3 hole |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0041-00 | | | 1 | SCREW, thread forming 6-32 x 3/8 inch THS phillips |
| 26 | 136-0095-00 | 100 | 169 | 4 | SOCKET, 4 pin transistor |
| | 136-0182-00 | 170 | | 4 | SOCKET, 4 pin transistor |
| | - - - - - - | | | - | mounting hardware for each: (not included w/socket) |
| | 213-0113-00 | 100 | 169 | 2 | SCREW, thread forming 2-32 x 5/16 inch RHS phillips |
| | 354-0234-00 | 170 | | 1 | RING, locking, transistor socket |

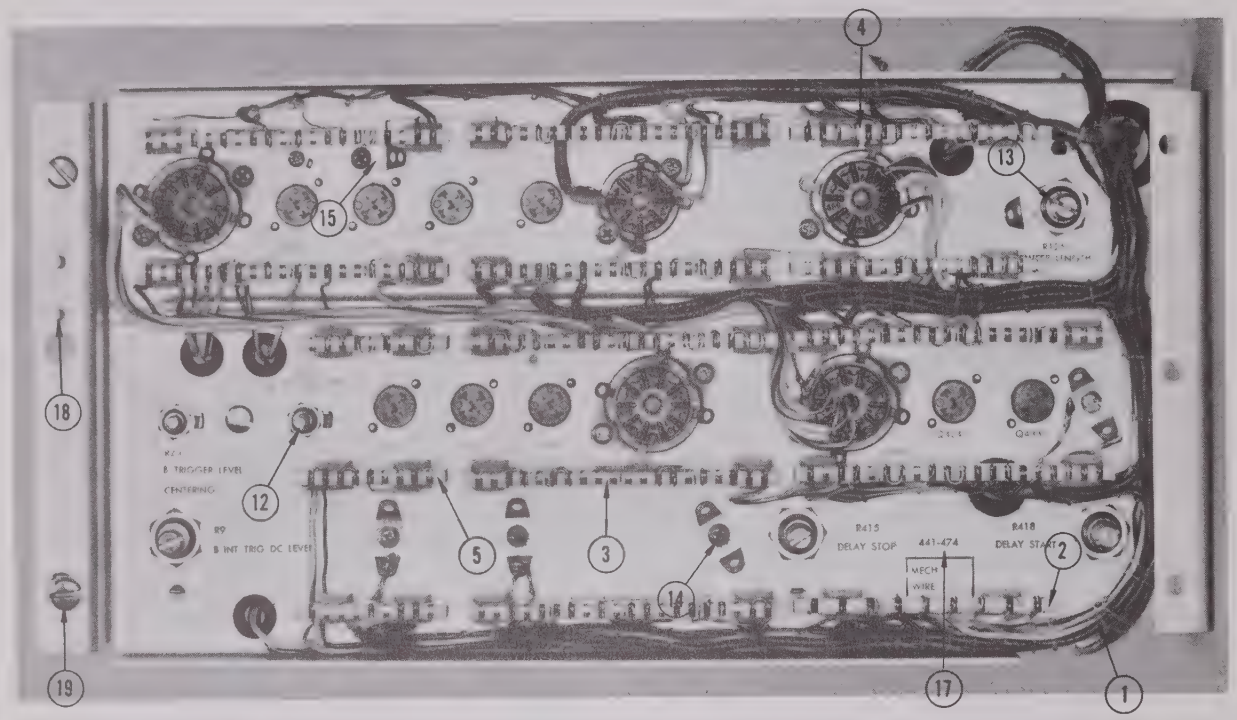
## FAN & SHUNT RESISTOR BRACKET

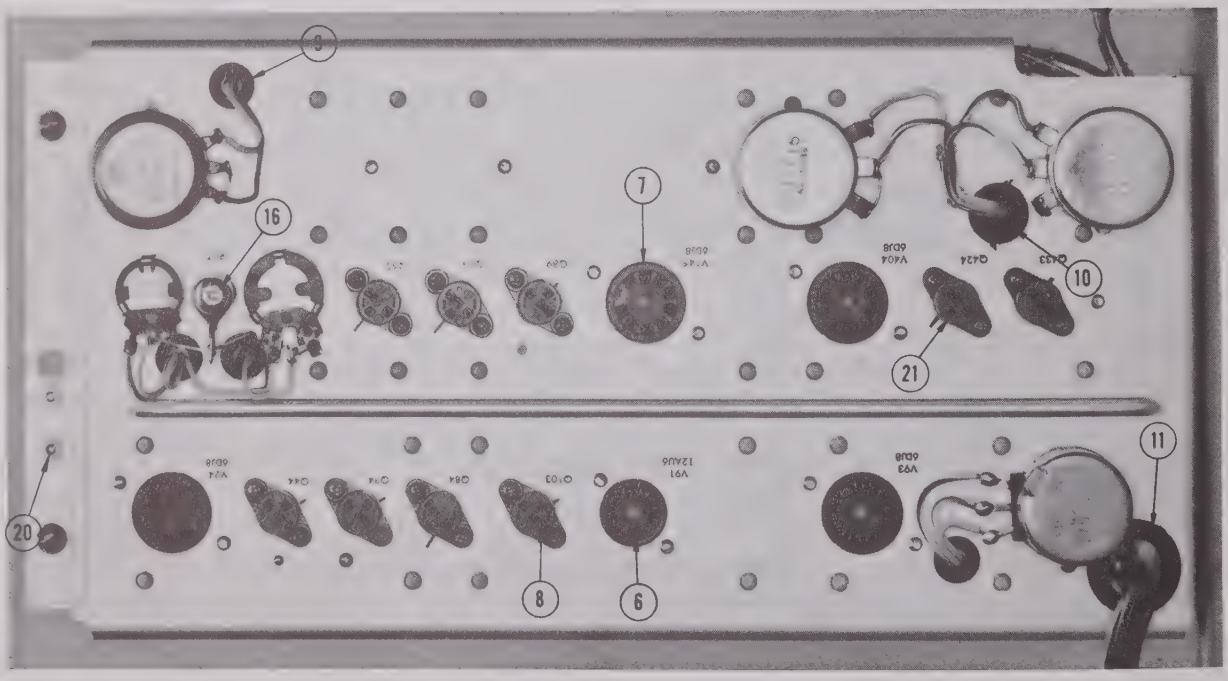



| REF. NO. | PART NO. | SERIAL/MODEL NO. DISC. | SERIAL/MODEL NO. EFF. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 426-193 | | | 1 | MOUNT, fan motor, $2^{1}/_{16} \times 2^{5}/_{8} \times 8^{13}/_{16}$ inches |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 212-039 | | | 4 | SCREW, 8-32 x $^{3}/_{8}$ inch, THS phillips |
| 2 | 147-026 | | | 1 | MOTOR, fan |
| | - - - - | | | - | Mounting Hardware: (not included) |
| 3 | 210-458 | | | 2 | NUT, keps, 8-32 x $^{11}/_{32}$ inch |
| 4 | 369-007 | | | 1 | FAN, 7 inch with rubber bushing |
| 5 | - - - - | | | - | Resistor Mounting Hardware 25 Watt: |
| | 210-008 | | | 1 | LOCKWASHER, internal, #8 |
| | 210-228 | | | 1 | LUG, solder, SE #8 long |
| | 210-462 | | | 1 | NUT, hex, 8-32 x $^{1}/_{2}$ x $^{23}/_{64}$ inch |
| | 210-809 | | | 1 | WASHER, centering |
| | 212-004 | | | 1 | SCREW, 8-32 x $^{5}/_{16}$ inch, BHS |
| | 212-037 | | | 1 | SCREW, 8-32 x $1^{3}/_{4}$ inch, Fil HS |
| 6 | - - - - | | | - | Resistor Mounting Hardware 20 Watt: |
| | 210-462 | | | 1 | NUT, hex, 8-32 x $^{1}/_{2}$ x $^{23}/_{64}$ inch |
| | 210-808 | | | 1 | WASHER, centering |
| | 210-004 | | | 1 | SCREW, 8-32 x $^{5}/_{16}$ inch, BHS |
| | 210-037 | | | 1 | SCREW, 8-32 x $1^{3}/_{4}$ inch, Fil HS |
| 7 | 348-004 | | | 2 | GROMMET, rubber, $^{3}/_{8}$ inch |
| 8 | 406-910 | | | 1 | BRACKET, shunt resistor |
| | - - - - | | | - | Mounting Hardware: (not included) |
| | 211-537 | | | 2 | SCREW, 6-32 x $^{3}/_{8}$ inch, THS phillips |

## DELAY SWEEP


4
13
15
18
12
B TRIGGER LEVEL
CENTERING
R9
B INT TRIG DC LEVEL
5
3
14
R415
DELAY STOP
441-474
MECH
WIRE
R418
DELAY START
2
17
1
19


9
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## DELAY SWEEP

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 179-0868-00 | 100 | 499 | 1 | CABLE, harness B sweep |
| | 179-0868-01 | 500 | | 1 | CABLE, harness B sweep |
| 2 | 124-0095-00 | | | 1 | STRIP, ceramic 7/16 inch x 9 notches |
| | - - - - - - | | | - | Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon .510 x .277 x .128 inch |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 361-0009-00 | | | 2 | SPACER, nylon |
| 3 | 124-0154-00 | | | 9 | STRIP, ceramic 20 notches x 3 long x 7/16 inch |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0082-00 | | | 2 | STUD, nylon .296 x .375 x .128 inch diameter |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0039-00 | | | 2 | SPACER, 1/4 diameter x 13/32 inch long |
| 4 | 124-0155-00 | | | 2 | STRIP, ceramic 16 notches x 2 7/16 x 7/16 inch |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0082-00 | | | 2 | STUD, .296 x .375 x .128 inch diameter |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0039-00 | | | 2 | SPACER, 1/4 diameter x 13/32 inch long |
| 5 | 124-0157-00 | | | 3 | STRIP, ceramic 9 notches x 1 7/16 x 7/16 inch |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0082-00 | | | 2 | STUD, .296 x .375 x .128 inch diameter |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0039-00 | | | 2 | SPACER, 1/4 diameter x 13/32 inch long |
| 6 | 136-0008-00 | | | 1 | SOCKET, STM7G |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread forming, 5-32 x 3/16 inch PHS |
| 7 | 136-0015-00 | | | 4 | SOCKET, STM9G |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread forming, 5-32 x 3/16 inch PHS |
| 8 | 136-0095-00 | 100 | 169 | 8 | SOCKET, 4 pin transistor |
| | 136-0181-00 | 170 | | 8 | SOCKET, 3 pin transistor |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0113-00 | 100 | 169 | 2 | SCREW, thread forming, 2-32 x 5/16 inch RHS |
| | 354-0234-00 | 170 | | 1 | RING, locking, transistor socket |
| 9 | 348-0003-00 | | | 4 | GROMMET, rubber 5/16 inch |
| 10 | 348-0004-00 | | | 1 | GROMMET, rubber 3/8 inch |
| 11 | 348-0006-00 | | | 1 | GROMMET, rubber 3/4 inch |
| 12 | - - - - - - | | | - | Miniature Pot Mounting Hardware: |
| | 210-0583-00 | | | 1 | NUT, hex, 1/4-32 x 5/16 inch |
| | 210-0940-00 | | | 1 | WASHER, 1/4 ID x 3/8 inch OD |
| 13 | - - - - - - | | | - | Pot Mounting Hardware: |
| | 210-0012-00 | | | 1 | LOCKWASHER, internal 3/8 x 1/2 inch |
| | 210-0207-00 | | | 1 | LUG, solder pot 3/8 inch |
| | 210-0413-00 | | | 1 | NUT, hex, 3/8-32 x 1/2 inch |
| | 210-0840-00 | | | 1 | WASHER, .390 ID x 9/16 inch OD |
| 14 | 210-0204-00 | | | 4 | LUG, solder DE #6 |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0044-00 | | | 1 | SCREW, thread forming, 5-32 x 3/16 inch PHS |

©

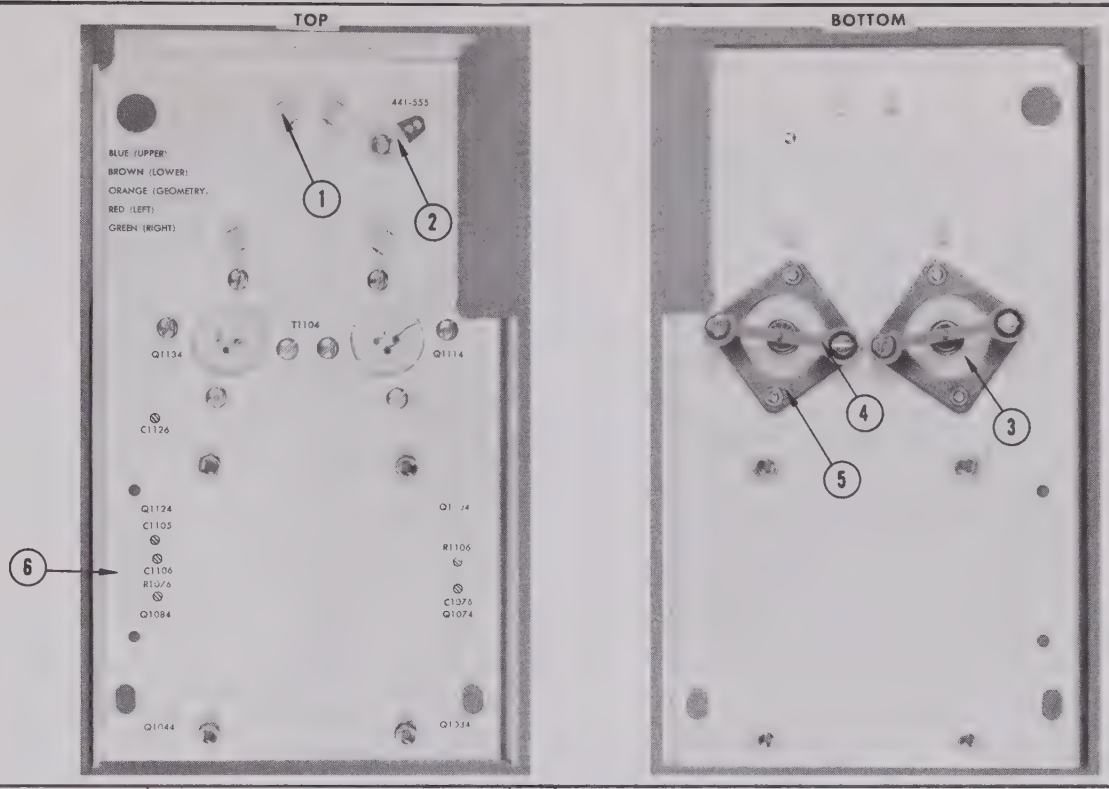
## DELAY SWEEP *(Cont.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 15 | 210-0201-00 | | | 1 | LUG, solder SE #4 |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0044-00 | | | 1 | SCREW, thread forming, 5-32 x 3/16 inch PHS |
| 16 | - - - - - - | | | - | Resistor Mounting Hardware: |
| | 210-0478-00 | | | 1 | NUT, hex. aluminum 5/16 x 21/32 inch long |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch BHS |
| | 211-0544-00 | | | 1 | SCREW, 6-32 x 1 1/2 inches RHS phillips |
| 17 | 441-0474-00 | | | 1 | CHASSIS, DELAY SWEEP |
| | - - - - - - | | | - | Includes: |
| 18 | 131-0269-00 | | | 2 | CONNECTOR, receptacle |
| 19 | 213-0172-00 | | | 2 | THUMBSCREW, 6-32 x 0.812 inch |
| | 354-0311-00 | 100 | 1189X | 2 | RING, rubber, 0.078 inch ID |
| 20 | 358-0214-00 | | | 2 | BUSHING, insulator |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0008-00 | | | 3 | SCREW, 8-32 x 1/2 inch BHS |
| 21 | 136-0095-00 | 100 | 169 | 1 | SOCKET, 4 pin transistor |
| | 136-0182-00 | 170 | | 1 | SOCKET, 4 pin transistor |
| | - - - - - - | | | - | mounting hardware: (not included w/socket) |
| | 213-0113-00 | 100 | 169 | 2 | SCREW, thread forming, 2-32 x 5/16 inch RHS |
| | 354-0234-00 | 170 | | 1 | RING, locking, transistor socket |



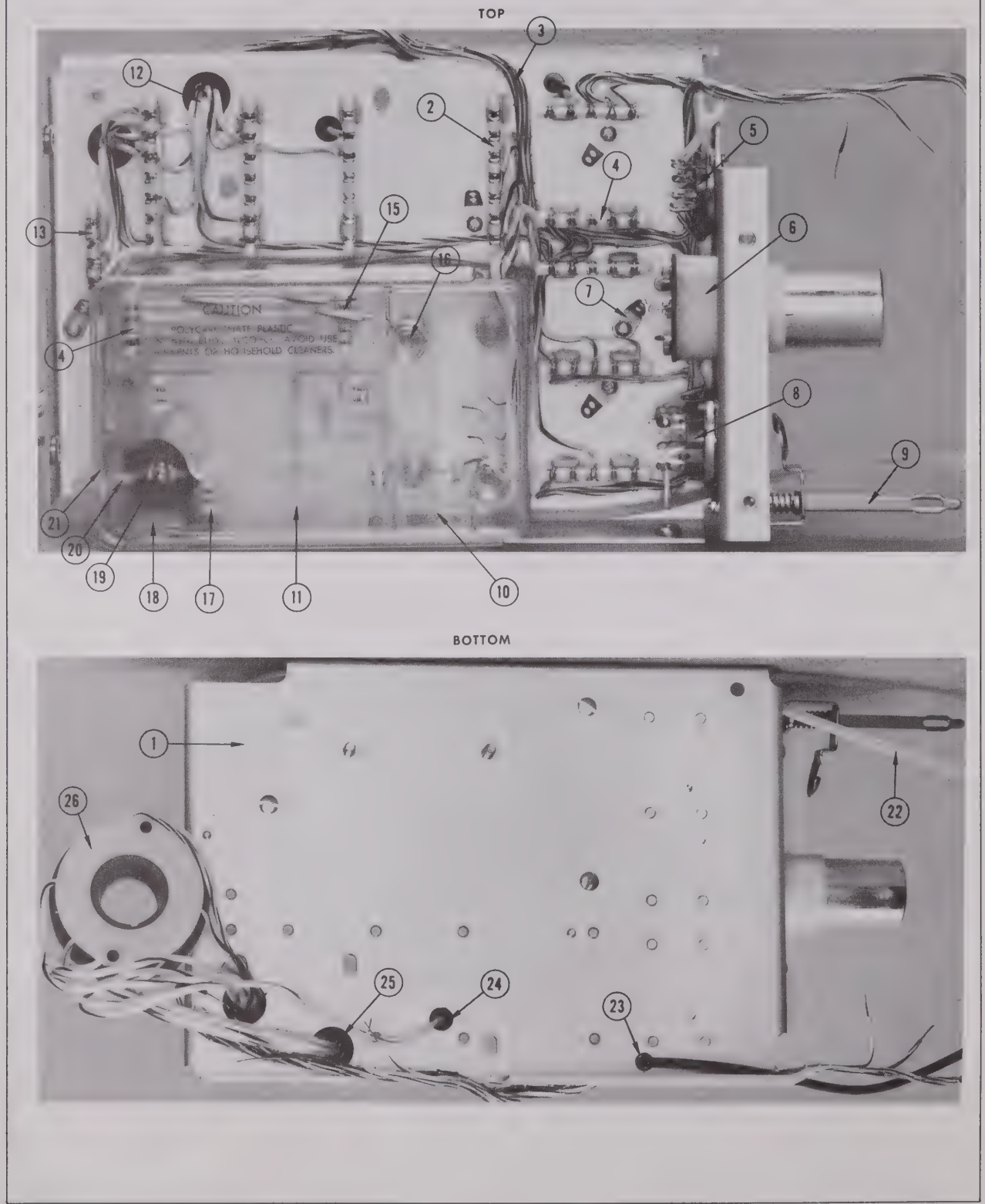
©

## UPPER VERTICAL AMPLIFIER




| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 129-0069-00 | | | 4 | POST, capacitor, tie |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0007-00 | | | 1 | SPACER, nylon |
| 2 | 210-0201-00 | | | 2 | LUG, solder SE #4 |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0044-00 | | | 1 | SCREW, thread forming, 5-32 x 3/16 inch PHS phillips |
| 3 | 214-0317-00 | | | 2 | HEAT SINK, insulator disc |
| | - - - - - - | | | - | Mounting Hardware For Each: (not included) |
| | 210-0406-00 | | | 4 | NUT, hex., 4-40 x 3/16 inch |
| | 210-0599-00 | | | 2 | NUT, sleeve |
| | 210-0627-00 | | | 1 | RIVET |
| | 211-0008-00 | | | 2 | SCREW, 4-40 x 1/4 inch BHS |
| | 211-0012-00 | | | 2 | SCREW, 4-40 x 3/8 inch BHS |
| | 214-0368-00 | | | 1 | SPRING, transistor heat sink holder |
| 4 | 343-0097-00 | | | 1 | CLAMP, transistor heat sink |
| 5 | 352-0062-00 | | | 1 | HOLDER, transistor heat sink |
| 6 | 441-0555-00 | | | 1 | CHASSIS |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0804-00 | | | 2 | WASHER, 8S x 3/8 inch |
| | 212-0004-00 | | | 2 | SCREW, 8-32 x 3/8 inch BHS |
| | 212-0023-00 | | | 2 | SCREW, 8-32 x 5/16 inch BHS |

## FOCUS, INTENSITY & HIGH VOLTAGE



## FOCUS, INTENSITY & HIGH VOLTAGE

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 441-0475-00 | | | 1 | CHASSIS, high voltage |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 212-0002-00 | | | 2 | SCREW, 8-32 x 1/4 inch, FHS phillips |
| | 212-0004-00 | | | 2 | SCREW, 8-32 x 5/16 inch, BHS |
| | 212-0008-00 | | | 1 | SCREW, 8-32 x 1/2 inch, BHS |
| | 210-0804-00 | | | 3 | WASHER, 8S x 3/8 inch |
| | 210-0458-00 | | | 1 | NUT, keps, 8-32 x 11/32 inch |
| 2 | 124-0089-00 | | | 4 | STRIP, ceramic, 3/4 inch x 7 notches |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0008-00 | | | 2 | SPACER, nylon, .188 inch |
| 3 | 179-0767-00 | | | 1 | CABLE HARNESS, high voltage |
| 4 | 124-0093-00 | | | 5 | STRIP, ceramic, 7/16 inch x 5 notches |
| | - - - - - - | | | - | EACH Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 361-0009-00 | | | 2 | SPACER, nylon, .313 inch |
| 5 | 136-0015-00 | | | 1 | SOCKET, STM9G |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0044-00 | | | 2 | SCREW, thread cutting, 4-40 x 1/4 inch, PHS phillips |
| 6 | 432-0047-00 | | | 1 | BASE, small capacitor mounting |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0514-00 | | | 2 | SCREW, 6-32 x 3/4 inch, BHS |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal, #6 |
| | 210-0407-00 | | | 2 | NUT, hex, 6-32 x 1/4 inch |
| | 386-0253-00 | | | 1 | PLATE, metal, small capacitor |
| 7 | 210-0201-00 | | | 5 | LUG, solder, SE #4 |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 213-0044-00 | | | 1 | SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips |
| 8 | 136-0011-00 | | | 1 | SOCKET, STM8 |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0538-00 | X180 | | 2 | SCREW, 6-32 x 5/16 inch, FHS |
| | 210-0407-00 | | | 2 | NUT, hex, 6-32 x 1/4 inch |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal, #6 |

©

## FOCUS, INTENSITY & HIGH VOLTAGE *(Cont'd)*

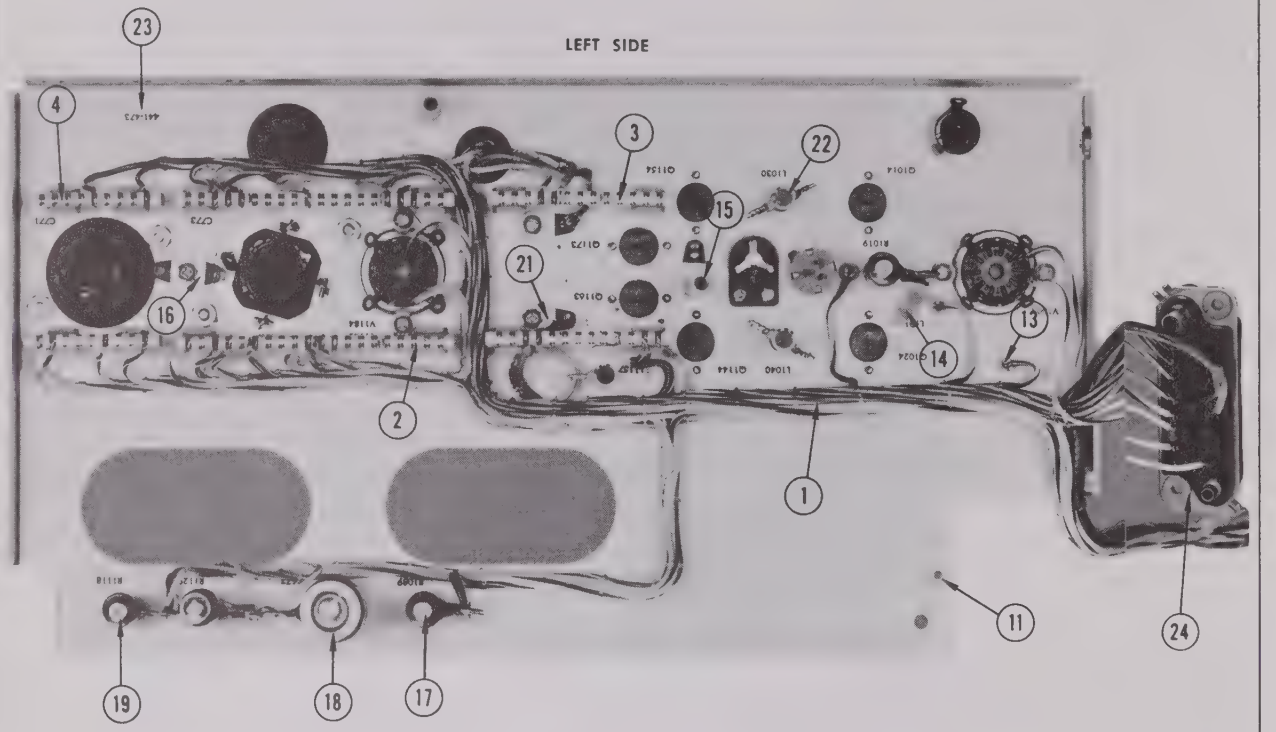
| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 9 | 343-0095-00 | | | 1 | CLAMP, tube |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0008-00 | | | 1 | SCREW, 4-40 x 1/4 inch, BHS |
| | 210-0004-00 | | | 1 | LOCKWASHER, internal, #4 |
| | 210-0406-00 | | | 1 | NUT, hex, 4-40 x 3/16 inch |
| 10 | 200-0475-00 | | | 1 | COVER, high voltage |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0521-00 | | | 2 | SCREW, 6-32 x 1 1/2 inches, RHS |
| | 210-0801-00 | | | 2 | WASHER, 5S x 9/32 inch |
| 11 | 392-0147-00 | | | 1 | BOARD, high voltage, with ceramic strips |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, BHS |
| 12 | 179-0769-00 | | | 1 | CABLE HARNESS, focus and intensity |
| 13 | 124-0120-00 | | | 1 | STRIP, ceramic, 7/16 inch x 4 notches |
| | - - - - - - | | | - | Includes: |
| | 355-0046-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 361-0008-00 | | | 2 | SPACER, nylon, .188 inch |
| 14 | 124-0164-00 | | | 2 | STRIP, ceramic, 4 notches |
| 15 | 124-0162-00 | | | 1 | STRIP, ceramic, 7/16 inch x 4 notches |
| | - - - - - - | | | - | Includes: |
| | 355-0046-00 | | | 1 | STUD, nylon |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 361-0007-00 | | | 1 | SPACER, nylon, .063 inch |
| 16 | - - - - - - | | | - | Mounting Hardware For High Voltage Transformer: |
| | 211-0553-00 | | | 2 | SCREW, 6-32 x 1 1/2 inches, RHS |
| | 210-0801-00 | | | 2 | WASHER, 5S x 9/32 inch |
| | 358-0228-00 | | | 2 | BUSHING, insulation |
| 17 | 124-0163-00 | | | 4 | STRIP, ceramic, 2 notches |
| 18 | 166-0319-00 | | | 2 | SLEEVE, high voltage |
| 19 | 210-0261-00 | | | 2 | LUG, solder, high voltage |
| | - - - - - - | | | - | Mounting Hardware For EACH: (not included) |
| | 211-0587-00 | | | 1 | SCREW, 6-32 x 3/16 inch, HHS |
| 20 | 166-0357-00 | | | 1 | SLEEVE, high voltage anode lead |
| 21 | 380-0048-00 | | | 1 | HOUSING, high voltage |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0507-00 | | | 3 | SCREW, 6-32 x 5/16 inch, BHS |
| 22 | 131-0350-00 | | | 1 | CONNECTOR, anode assembly |
| | - - - - - - | | | - | Includes: |
| | 175-0012-00 | | | FT. | CABLE, high voltage, poly. insulated |
| | 200-0110-00 | | | 1 | CAP, crt anode, black polyethylene, 3/4 inch OD |
| | 214-0358-00 | | | 1 | SPRING, crt anode connector |
| | 432-0046-00 | | | 1 | BASE, crt anode connector, molded delrin, 3/4 inch |

## FOCUS, INTENSITY & HIGH VOLTAGE *(Cont'd.)*

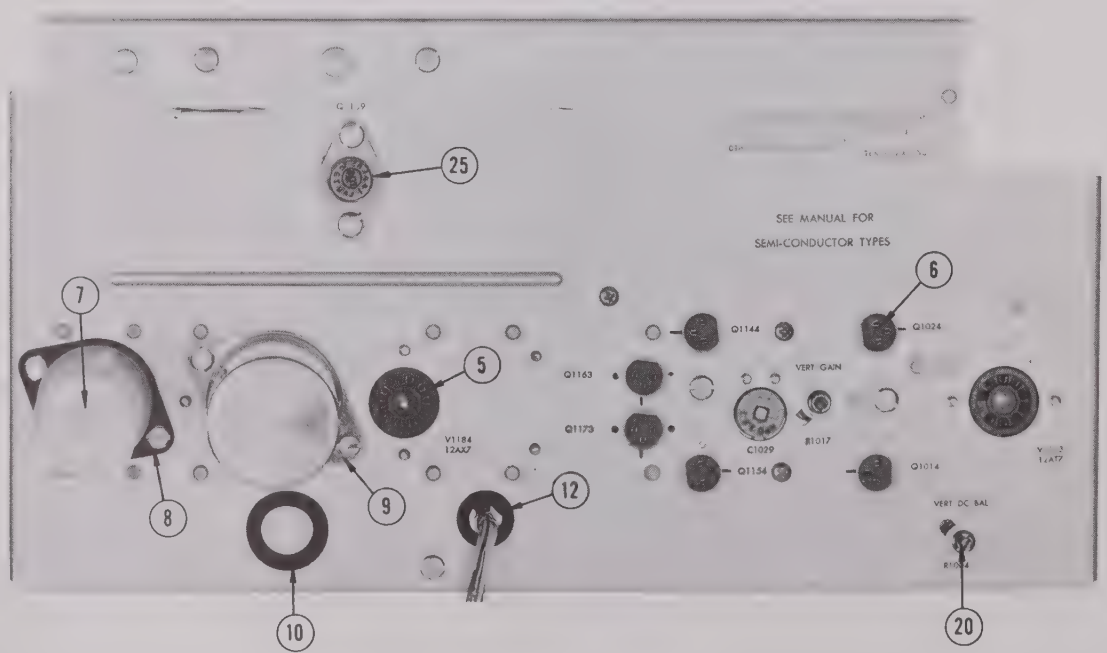
| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 23 | 348-0055-00 | | | 2 | GROMMET, plastic, 1/4 inch, snap in |
| 24 | 348-0002-00 | | | 1 | GROMMET, rubber, 1/4 inch |
| 25 | 348-0005-00 | | | 2 | GROMMET, rubber, 1/2 inch |
| 26 | 136-0168-00 | | | 1 | SOCKET, crt, assembly |
| | - - - - - - | | | - | Includes: |
| | 136-0177-00 | | | 1 | SOCKET, crt, raw |
| | 131-0178-00 | | | 8 | CONNECTOR, cable end, crt |
| | 387-0393-00 | | | 1 | PLATE, back, crt socket |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 213-0086-00 | | | 2 | SCREW, thread cutting, 2-32 x 7/16 inch, PHS |

## LOWER VERTICAL AMPLIFIER

LEFT SIDE




RIGHT SIDE



## LOWER VERTICAL AMPLIFIER

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 179-0770-00 | 100 | 169 | 1 | CABLE HARNESS, lower vertical amplifier |
| | 179-0770-01 | 170 | | 1 | CABLE HARNESS, lower vertical amplifier |
| 2 | 124-0154-00 | | | 2 | STRIP, ceramic, 7/16 inch x 20 notches |
| | - - - - - - | | | - | each strip includes: |
| | 355-0082-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | mounting hardware for each: (not included w/strip) |
| | 361-0039-00 | | | 2 | SPACER, nylon, 13/32 inch |
| 3 | 124-0156-00 | | | 2 | STRIP, ceramic, 7/16 inch x 13 notches |
| | - - - - - - | | | - | each strip includes: |
| | 355-0082-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | mounting hardware for each: (not included w/strip) |
| | 361-0039-00 | | | 2 | SPACER, nylon, 13/32 inch |
| 4 | 124-0157-00 | | | 2 | STRIP, ceramic, 7/16 inch x 9 notches |
| | - - - - - - | | | - | each strip includes: |
| | 355-0082-00 | | | 2 | STUD, nylon |
| | - - - - - - | | | - | mounting hardware for each: (not included w/strip) |
| | 361-0039-00 | | | 2 | SPACER, nylon, 13/32 inch |
| 5 | 136-0015-00 | | | 2 | SOCKET, STM9G |
| | - - - - - - | | | - | mounting hardware for each: (not included w/socket) |
| | 213-0044-00 | | | 2 | SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips |
| 6 | 136-0095-00 | 100 | 169 | 6 | SOCKET, 4 pin transistor |
| | 136-0181-00 | 170 | | 6 | SOCKET, 3 pin transistor |
| | - - - - - - | | | - | mounting hardware for each: (not included w/socket) |
| | 213-0113-00 | 100 | 169 | 2 | SCREW, thread forming, 2-32 x 5/16 inch, RHS phillips |
| | 354-0234-00 | 170 | | 1 | RING, locking, transistor socket |
| 7 | 200-0257-00 | | | 1 | COVER, capacitor |
| 8 | - - - - - - | | | 1 | CAPACITOR |
| | - - - - - - | | | - | mounting hardware: (not included w/capacitor) |
| | 386-0252-00 | | | 1 | PLATE, fiber, small capacitor |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal, #6 |
| | 210-0407-00 | | | 2 | NUT, hex, 6-32 x 1/4 inch |
| | 211-0534-00 | | | 2 | SCREW, 6-32 x 5/16 inch, PHS w/lockwasher |
| 9 | - - - - - - | | | 1 | CAPACITOR |
| | - - - - - - | | | - | mounting hardware: (not included w/capacitor) |
| | 386-0255-00 | | | 1 | PLATE, metal, large capacitor |
| | 210-0006-00 | | | 2 | LOCKWASHER, internal, #6 |
| | 210-0407-00 | | | 2 | NUT, hex, 6-32 x 1/4 inch |
| | 211-0534-00 | | | 2 | SCREW, 6-32 x 5/16 inch, PHS w/lockwasher |
| 10 | 348-0006-00 | | | 1 | GROMMET, 3/4 inch |
| 11 | 348-0031-00 | | | 1 | GROMMET, snap-in |
| 12 | 348-0005-00 | | | 1 | GROMMET, 1/2 inch |
| 13 | 131-0235-00 | | | 3 | CONNECTOR, terminal |
| | - - - - - - | | | - | mounting hardware for each: (not included w/connector) |
| | 358-0136-00 | | | 1 | BUSHING, teflon |

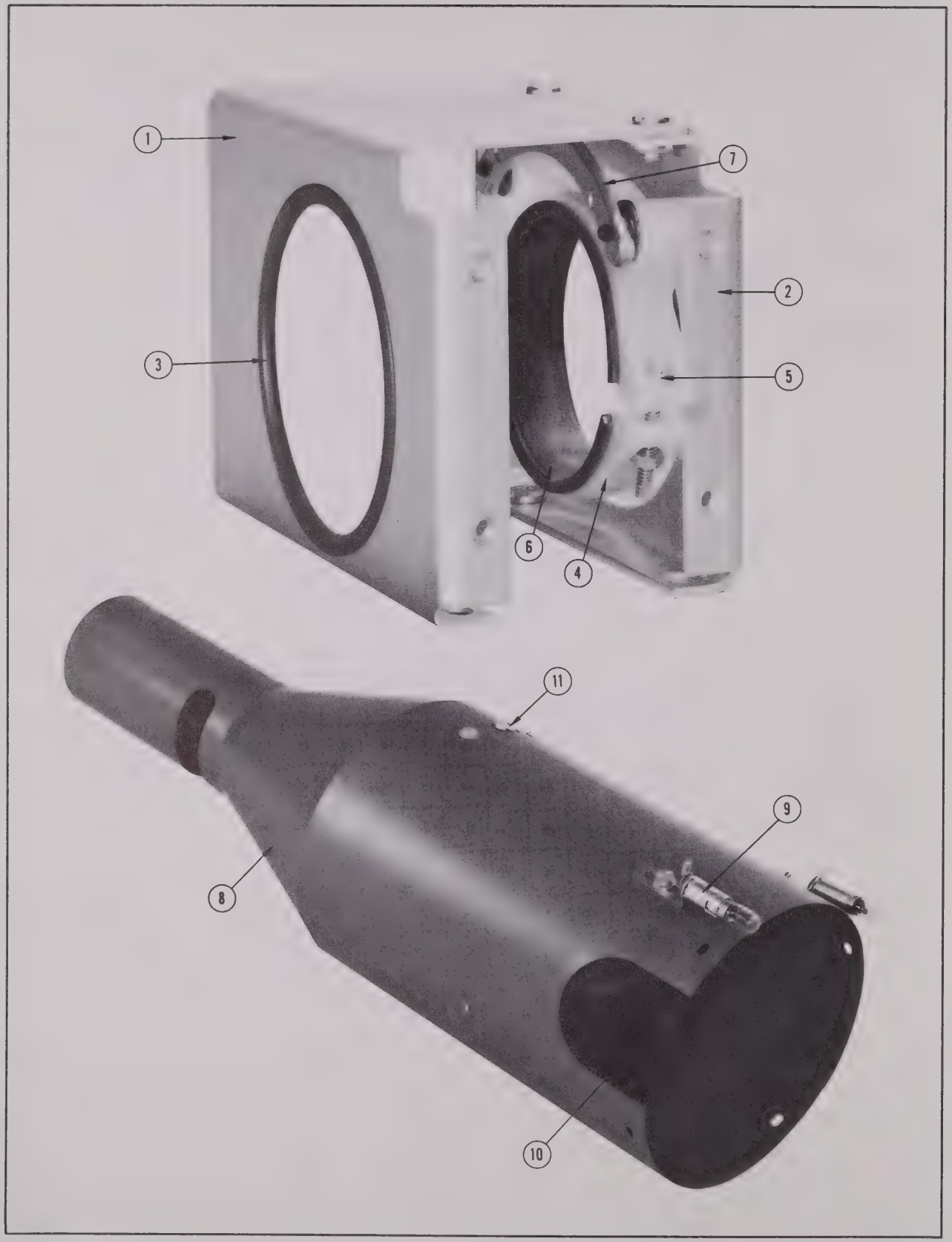
## LOWER VERTICAL AMPLIFIER *(Cont'd.)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 14 | 426-0121-00 | | | 1 | MOUNT, toroid |
| | - - - - - - | | | - | mounting hardware: (not included w/mount) |
| | 361-0007-00 | | | 1 | SPACER, nylon |
| 15 | 385-0024-00 | | | 2 | ROD, aluminum |
| | - - - - - - | | | - | mounting hardware for each: (not included w/rod) |
| | 210-0202-00 | | | 1 | LUG, solder, SE6 |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, BHS |
| 16 | 210-0204-00 | | | 1 | LUG, solder, DE6 |
| | - - - - - - | | | - | mounting hardware: (not included w/lug) |
| | 213-0044-00 | | | 1 | SCREW, thread forming, 5-32 x 3/16 inch, PHS |
| 17 | - - - - - - | | | - | RESISTOR |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| | 210-0203-00 | | | 1 | LUG, solder, SE6, long |
| | 210-0478-00 | | | 1 | NUT, hex, resistor mounting |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, BHS |
| | 211-0544-00 | | | 1 | SCREW, 6-32 x 3/4 inch, THS phillips |
| 18 | - - - - - - | | | 1 | RESISTOR |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| | 210-0008-00 | | | 1 | LOCKWASHER, internal, #8 |
| | 210-0462-00 | | | 1 | NUT, hex, resistor mounting |
| | 210-0809-00 | | | 1 | WASHER, centering |
| | 212-0004-00 | | | 1 | SCREW, 8-32 x 5/16 inch, BHS |
| | 212-0037-00 | | | 1 | SCREW, 8-32 x 1 3/4 inches, Fil HS |
| 19 | - - - - - - | | | 1 | RESISTOR |
| | - - - - - - | | | - | mounting hardware: (not included w/resistor) |
| | 210-0203-00 | | | 1 | LUG, solder, SE6, long |
| | 210-0478-00 | | | 1 | NUT, hex, resistor mounting |
| | 210-0601-00 | | | 1 | EYELET |
| | 211-0507-00 | | | 1 | SCREW, 6-32 x 5/16 inch, BHS |
| | 211-0553-00 | | | 1 | SCREW, 6-32 x 1 1/2 inches, RHS phillips |
| 20 | - - - - - - | | | 1 | POT |
| | - - - - - - | | | - | mounting hardware: (not included w/pot) |
| | 210-0046-00 | | | 1 | LOCKWASHER, internal, .400 OD x .261 inch ID |
| | 210-0223-00 | | | 1 | LUG, solder, 1/4 inch |
| | 210-0583-00 | | | 1 | NUT, hex, 1/4-32 x 5/16 inch |
| | 210-0940-00 | | | 1 | WASHER, 1/4 ID x 3/8 inch OD |

## LOWER VERTICAL AMPLIFIER *(Cont'd)*

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 21 | 210-0201-00 | | | 2 | LUG, solder, SE4 |
| | - - - - - - | | | - | mounting hardware for each: (not included w/lug) |
| | 213-0044-00 | | | 1 | SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips |
| 22 | - - - - - - | | | 1 | COIL |
| | - - - - - - | | | - | mounting hardware: (not included w/coil) |
| | 213-0088-00 | | | 1 | SCREW, thread forming, 4-40 x 1/4 inch, PHS phillips |
| 23 | 441-0473-00 | 100 | 169 | 1 | CHASSIS, lower vertical amplifier |
| | 441-0473-01 | 170 | | 1 | CHASSIS, lower vertical amplifier |
| | - - - - - - | | | - | mounting hardware: (not included w/chassis) |
| | 210-0457-00 | | | 2 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0803-00 | | | 2 | WASHER, 6L x 3/8 inch |
| | 210-0804-00 | | | 5 | WASHER, 8S x 3/8 inch |
| | 211-0507-00 | | | 2 | SCREW, 6-32 x 5/16 inch, BHS |
| | 212-0004-00 | | | 5 | SCREW, 8-32 x 5/16 inch, BHS |
| | 212-0039-00 | | | 2 | SCREW, 8-32 x 3/8 inch, THS phillips |
| | 406-0963-00 | | | 1 | BRACKET, support |
| 24 | 131-0018-00 | | | 1 | CONNECTOR, 16 contact |
| | - - - - - - | | | - | mounting hardware: (not included w/connector) |
| | 166-0107-00 | 100 | 449 | 2 | TUBE, spacer, 7/32 inch |
| | 166-0030-00 | 450 | | 2 | TUBE, spacer, 3/16 inch |
| | 210-0004-00 | | | 2 | LOCKWASHER, internal, #4 |
| | 210-0801-00 | | | 2 | WASHER, 5S x 9/32 inch |
| | 210-0406-00 | | | 2 | NUT, hex, 4-40 x 3/16 inch |
| | 211-0016-00 | | | 2 | SCREW, 4-40 x 5/8 inch, RHS |
| 25 | - - - - - - | X170 | | 1 | TRANSISTOR |
| | - - - - - - | | | - | mounting hardware: (not included w/transistor) |
| | 386-0143-00 | | | 1 | PLATE, mica insulator |
| | 211-0510-00 | | | 2 | SCREW, 6-32 x 3/8 inch, PHS phillips |
| | 210-0983-00 | 170 | 599 | 2 | WASHER, shoulder |
| | 210-0935-00 | 600 | | 2 | WASHER, fiber, 0.140 ID x 0.375 inch OD |
| | 210-0802-00 | | | 2 | WASHER, 6S x 5/16 inch |
| | 210-0006-00 | 170 | 459X | 1 | LOCKWASHER, internal, #6 |
| | 210-0202-00 | | | 1 | LUG, solder, SE6 |
| | 210-0407-00 | 170 | 459 | 2 | NUT, hex, 6-32 x 1/4 inch |
| | 210-0457-00 | 460 | | 2 | NUT, keps, 6-32 x 5/16 inch |

## CRT MOUNTING BRACKET & CRT SHIELD



## CRT MOUNTING BRACKET & CRT SHIELD

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 407-0004-00 | | | 1 | BRACKET, crt Shield .063 aluminum 2.593 x 3.593 x 5.938 |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 212-0004-00 | | | 1 | SCREW, 8-32 x 5/16 inch BHS |
| | 210-0458-00 | | | 2 | NUT, keps steep, 8-32 x 11/32 inch |
| | 210-0804-00 | | | 1 | WASHER, steel 8S x 3/8 x .032 inch |
| 2 | 407-0994-00 | | | 1 | BRACKET, crt aluminum .562 x 4.125 x 3.531 |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 210-0458-00 | | | 3 | NUT, keps steel 8-32 x 11/32 inch |
| | 210-0804-00 | | | 2 | WASHER, steel 8S x 3/8 x .032 inch |
| | 212-0004-00 | | | 5 | SCREW, 8-32 x 5/16 inch BHS |
| 3 | 252-0564-00 | | | FT | POLYETHYLENE, extruded channel cushion (8 5/8 inches) |
| 4 | 354-0215-00 | | | 1 | RING, clamping screw assembly |
| | - - - - - - | | | - | Consisting Of: |
| | 210-0407-00 | | | 1 | NUT, hex, 6-32 x 1/4 inch |
| 5 | 211-0560-00 | | | 1 | SCREW, 6-32 x 1 inch RHS |
| | 354-0211-00 | | | 1 | RING, clamping delrin 1 1/2 x 2.312 inch ID, with 2 mounting ears |
| | - - - - - - | | | - | |
| 6 | 124-0160-00 | | | 1 | STRIP, liner, crt clamp |
| 7 | 214-0207-00 | | | 1 | NUT, adj. securing Zamak #5 .312 inch wide x 110° arc with 2 6-32 tapped holes |
| | - - - - - - | | | - | |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0576-00 | | | 2 | SCREW, 6-32 x 7/8 inch socket head |
| | 210-0949-00 | | | 4 | WASHER, brass 1/16 x 9/64 ID x 1/2 inch OD |
| 8 | 337-0620-00 | | | 1 | SHIELD, crt .025 x 5.562 diameter x 18.125 inch long |
| | - - - - - - | | | - | Mounting Hardware: (not included) |
| | 211-0504-00 | | | 4 | SCREW, 6-32 x 1/4 inch BHS |
| 9 | 136-0035-00 | | | 2 | SOCKET, graticule light with ground lug |
| | - - - - - - | | | - | Mounting Hardware For Each: (not included) |
| | 210-0457-00 | | | 1 | NUT, keps 6-32 x 5/16 inch |
| | 211-0534-00 | | | 1 | SCREW, 6-32 x 5/16 inch PHS with lockwasher |
| 10 | 200-0112-00 | | | 1 | COVER, crt anode assembly |
| | - - - - - - | | | - | Cover includes: |
| | 200-0111-00 | | | 1 | COVER, crt anode |
| | 386-0647-00 | | | 1 | PLATE, crt anode |
| | 134-0031-00 | | | 1 | PLUG, crt contact (not shown) |
| 11 | - - - - - - | | | 1 | Coil Mounting Hardware: (not included) |
| | 210-0457-00 | | | 3 | NUT, keps, 6-32 x 5/16 inch |
| | 210-0803-00 | X170 | | 3 | WASHER, steel 6L x 3/8 inch flat |
| | 211-0507-00 | 100 | 169 | 3 | SCREW, 6-32 x 5/16 inch BHS |
| | 211-0596-00 | 170 | | 3 | SCREW, 6-32 x 3/8 inch PHB phillips |
| | 210-0811-00 | X170 | | 3 | WASHER, fiber, #6 |

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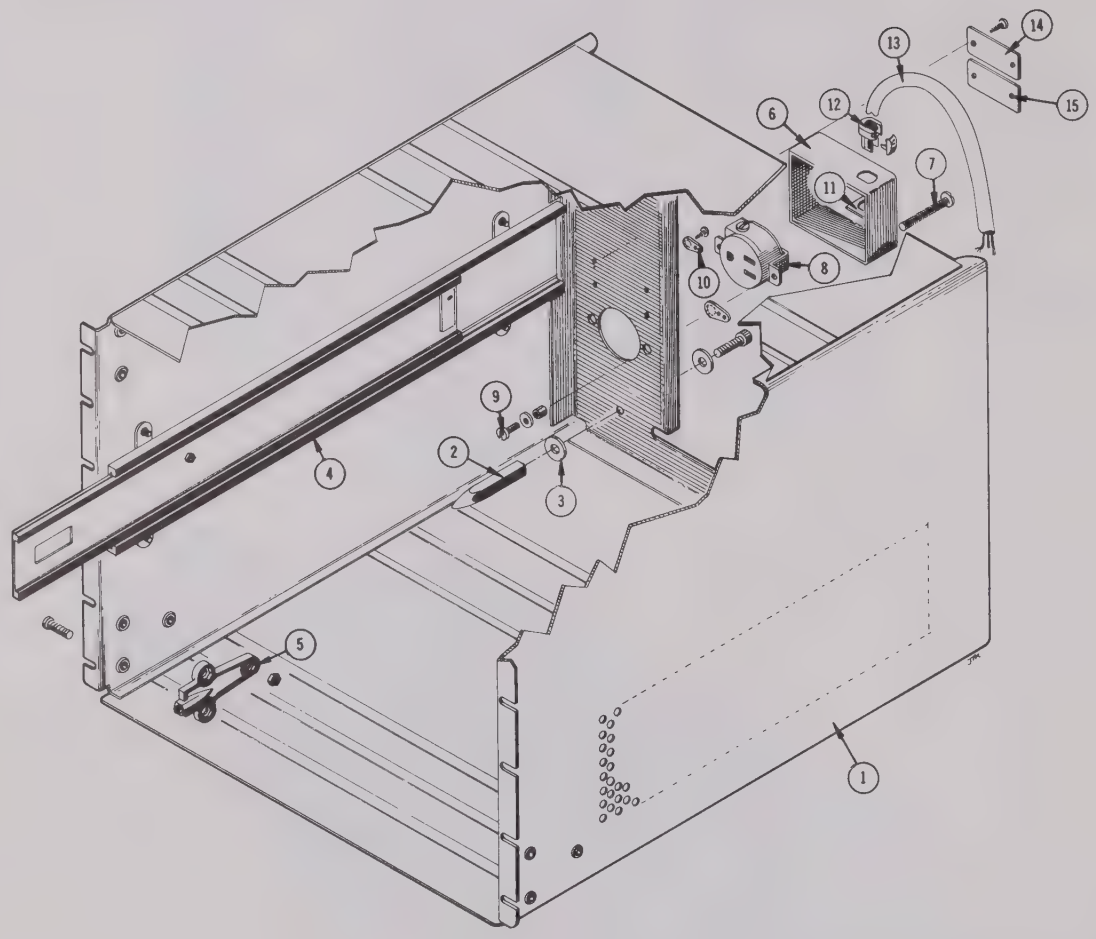
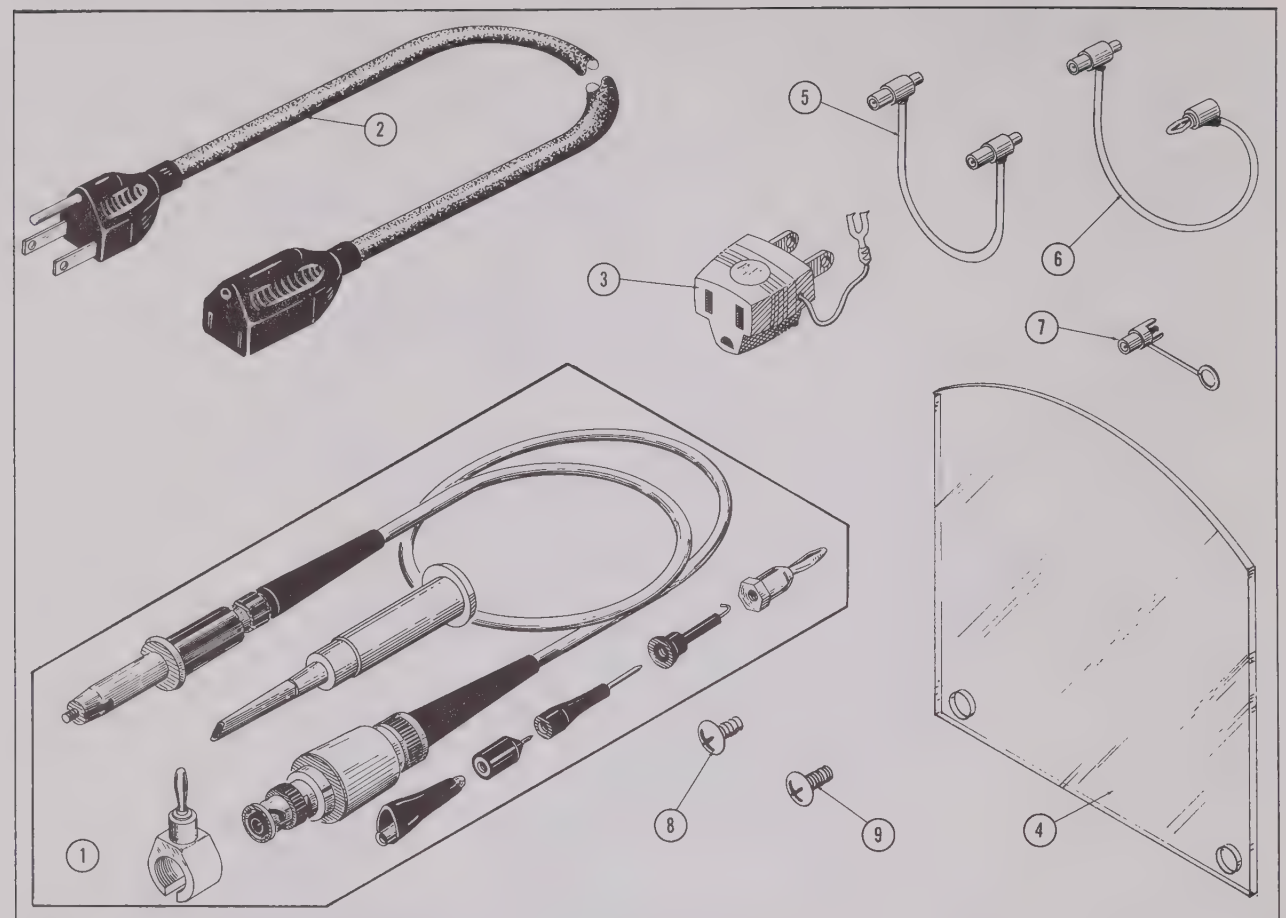
## CABINET



## CABINET

| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 437-0073-00 | | | 1 | CABINET, rackmount |
| | - - - - - - | | | - | cabinet includes: |
| 2 | 214-0426-00 | | | 2 | PIN, guide |
| 3 | - - - - - - | | | - | mounting hardware for each: (not included w/pin alone) |
| | 210-0866-00 | | | 2 | WASHER, .264 ID x 1 1/8 inches OD |
| | 213-0129-00 | | | 1 | SCREW, socket, 1/4-20 x 3/4 inch |
| 4 | 351-0078-00 | | | 1 | GUIDE, cabinet chassis track (1 pair) |
| | - - - - - - | | | - | mounting hardware: (not included w/guide alone) |
| | 210-0458-00 | | | 8 | NUT, keps, 8-32 x 11/32 inch |
| 5 | 351-0074-00 | | | 4 | GUIDE, instrument position and lock |
| | - - - - - - | | | - | mounting hardware for each: (not included w/guide alone) |
| | 212-0023-00 | | | 3 | SCREW, 8-32 x 3/8 inch, BHS |
| | 210-0409-00 | | | 3 | NUT, hex, 8-32 x 5/16 inch |
| 6 | 380-0066-00 | | | 1 | HOUSING, inlet |
| | - - - - - - | | | - | mounting hardware: (not included w/housing) |
| 7 | 211-0529-00 | | | 2 | SCREW, 6-32 x 1 1/4 inches, BHS |
| 8 | 136-0036-00 | | | 1 | SOCKET, grounding |
| | - - - - - - | | | - | mounting hardware: (not included w/socket) |
| 9 | 212-0023-00 | | | 2 | SCREW, 8-32 x 3/8 inch, BHS |
| | 210-0804-00 | | | 2 | WASHER, 8S x 3/8 inch |
| | 166-0029-00 | | | 2 | TUBE, spacer |
| | 210-0205-00 | | | 1 | LUG, solder, SE8 |
| 10 | 210-0201-00 | | | 1 | LUG, solder, SE4 |
| | - - - - - - | | | - | mounting hardware: (not included w/lug) |
| | 213-0044-00 | | | 1 | SCREW, thread cutting, 5-32 x 3/16 inch, PHS phillips |
| 11 | 361-0011-00 | | | 1 | SPACER, socket shield |
| 12 | 358-0025-00 | | | 1 | BUSHING, strain relief |
| 13 | 161-0017-00 | | | 1 | CORD, power |
| 14 | 334-0904-00 | | | 1 | TAG, voltage rating |
| | - - - - - - | | | - | mounting hardware: (not included w/tag) |
| | 213-0088-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch, PHS, phillips |
| 15 | 334-0927-00 | | | 1 | TAG, fuse data |
| | - - - - - - | | | - | mounting hardware: (not included w/tag) |
| | 213-0088-00 | | | 2 | SCREW, thread forming, 4-40 x 1/4 inch, PHS phillips |

## ACCESSORIES




| REF. NO. | PART NO. | SERIAL/MODEL NO. EFF. | SERIAL/MODEL NO. DISC. | QTY. | DESCRIPTION |
|---|---|---|---|---|---|
| 1 | 010-0129-00 | | | 2 | PROBE, package, P6008 |
| 2 | 161-0010-00 | 100 | 479 | 1 | CORD, power |
| | 161-0010-03 | 480 | | 1 | CORD, power |
| 3 | 103-0013-00 | | | 1 | ADAPTER, 3 to 2 wire |
| 4 | 387-0918-00 | | | 1 | PLATE, protector |
| | 378-0545-00 | 100 | 169 | 1 | FILTER, light, smoke gray (installed) |
| | 378-0567-00 | 170 | | 1 | FILTER, light, smoke gray (installed) |
| 5 | 012-0031-00 | 100 | 169 | 2 | CORD, patch |
| | 012-0087-00 | 170 | | 3 | CORD, patch |
| 6 | 012-0091-00 | X170 | | 1 | CORD, patch |
| 7 | 012-0092-00 | X170 | | 1 | JACK, BNC — post |
| 8 | 212-0533-00 | | | 12 | SCREW, 10-24 x 5/16 inch, THS phillips |
| 9 | 212-0535-00 | | | 12 | SCREW, 10-32 x 5/16 inch, THS phillips |
| | 103-0033-00 | 100 | 169X | 3 | ADAPTER, BNC to binding post (not shown) |
| | 070-0421-00 | | | 2 | MANUAL, instruction (not shown) |

# ELECTRICAL PARTS

Values are fixed unless marked Variable.

| Ckt. No. | Tektronix Part No. | Description | | | | S/N Range |
|---|---|---|---|---|---|---|
| | | **Bulbs** | | | | |
| B89 | 150-030 | Neon, NE-2V | READY | | | |
| B90W | 150-030 | Neon, NE-2V | UNCALIBRATED | | | |
| B94 | 150-027 | Neon, NE-23 | | | | |
| B289 | 150-030 | Neon, NE-2V | READY | | | |
| B290W | 150-030 | Neon, NE-2V | UNCALIBRATED | | | |
| B294 | 150-027 | Neon, NE-23 | | | | |
| B550 | 150-030 | Neon, NE-2V | MAG ON | | | |
| B579 | 150-037 | Neon, ST2-27S | | | | |
| B583 | 150-027 | Neon, NE-2V | | | | |
| B589 | 150-037 | Neon, ST2-27S | | | | |
| B602 | 150-001 | Incandescent, #47 | Pilot Light | | | |
| B603 | 150-031 | Incandescent, #44 | Graticule Light | | | |
| B604 | 150-031 | Incandescent, #44 | Graticule Light | | | |
| B1184 | 150-030 | Neon, NE-2V | | | | |
| B1194 | 150-030 | Neon, NE-2V | | | | |

**Capacitors**

Tolerance ±20% unless otherwise indicated.

Tolerance of all electrolytic capacitors as follows (with exceptions):

3 V — 50 V = −10%, +250%
51 V — 350 V = −10%, +100%
351 V — 450 V = −10%, + 50%

| | | | | | | |
|---|---|---|---|---|---|---|
| C1 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C2 | 281-523 | 100 pf | Cer | 350 v | | |
| C4 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C5 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C6 | 281-512 | 27 pf | Cer | 500 v | 10% | |
| C8 | Use 283-057 | 0.1 μf | Cer | 200 v | | |
| C11 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C12 | 281-523 | 100 pf | Cer | 350 v | | |
| C18 | 283-067 | 0.001 μf | Cer | 200 v | 10% | |
| C41 | 281-523 | 100 pf | Cer | 350 v | | 100-499X |
| C43 | 281-525 | 470 pf | Cer | 500 v | | 100-499X |
| C49 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C50 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C51 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C53 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C56 | 281-576 | 11 pf | Cer | 500 v | 5% | 100-499X |
| C56 | 281-0578-00 | 18 pf | Cer | 500 v | 5% | X500-up |
| C57 | 281-0578-00 | 18 pf | Cer | 500 v | 5% | X500-up |
| C67 | 283-026 | 0.2 μf | Cer | 25 v | | |
| C76 | 290-187 | 4.7 μf | EMT | 35 v | | 100-499 |
| C76 | 290-0175-00 | 10 μf | EMT | 35 v | | 500-up |
| C78 | 283-003 | 0.01 μf | Cer | 150 v | | |
| C83 | 281-524 | 150 pf | Cer | 500 v | | |

**Capacitors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | | | | S/N Range |
|---|---|---|---|---|---|---|
| C85 | 281-519 | 47 pf | Cer | 500 v | 10% | |
| C90A | 281-007 | 3-12 pf | Cer Var | | | |
| C90B | 281-007 | 3-12 pf | Cer Var | | | |
| C90C | 281-010 | 4.5-25 pf | Cer Var | | | |
| C90D | 281-574 | 82 pf | Cer | 500 v | 10% | |
| C90E | *295-073 | 0.001 μf | Timing Series | | | 100-479 |
| C90F | | 0.01 μf | | | | |
| C90G | | 0.1 μf | | | | |
| C90H | | 1 μf | | | | |
| C90J | | 10 μf | | | | |
| C90E | *295-0104-00 | 0.001 μf | Timing Series | | | 480-up |
| C90F | | 0.01 μf | | | | |
| C90G | | 0.1 μf | | | | |
| C90H | | 1 μf | | | | |
| C90J | | 10 μf | | | | |
| C90K | 281-524 | 150 pf | Cer | 500 v | | |
| C92 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C94 | 281-578 | 18 pf | Cer | 500 v | 5% | |
| C96 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C98 | Use 281-604 | 2.2 pf | Cer | 500 v | ±0.25 pf | |
| C99 | 281-007 | 3-12 pf | Cer Var | | | |
| C101 | 281-523 | 100 pf | Cer | 350 v | | |
| C103 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C128 | 281-550 | 120 pf | Cer | 500 v | 10% | |
| C130A | 281-550 | 120 pf | Cer | 500 v | 10% | |
| C130B | 285-543 | 0.0022 μf | PTM | 400 v | | |
| C130C | 285-636 | 0.022 μf | PTM | 200 v | | |
| C130D | 285-633 | 0.22 μf | PTM | 100 v | 10% | |
| C130E | 285-576 | 1 μf | PTM | 100 v | 10% | |
| C137 | 281-523 | 100 pf | Cer | 350 v | | |
| C144 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C146 | 281-512 | 27 pf | Cer | 500 v | 10% | |
| C166 | 281-543 | 270 pf | Cer | 500 v | 10% | |
| C170 | 281-605 | 200 pf | Cer | 500 v | | |
| C181 | 281-544 | 5.6 pf | Cer | 500 v | 10% | |
| C184 | 281-512 | 27 pf | Cer | 500 v | 10% | |
| C186 | 281-012 | 7-45 pf | Cer Var | | | |
| C188 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C192 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C197 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C199 | 281-511 | 22 pf | Cer | 500 v | 10% | |
| C201 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C202 | 281-523 | 100 pf | Cer | 350 v | | |
| C204 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C205 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C206 | 281-512 | 27 pf | Cer | 500 v | 10% | |
| C211 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C212 | 281-523 | 100 pf | Cer | 350 v | | |
| C218 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C241 | 281-523 | 100 pf | Cer | 350 v | | 100-499X |
| C243 | 281-525 | 470 pf | Cer | 500 v | | 100-499X |
| C249 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C253 | 283-000 | 0.001 μf | Cer | 500 v | | |

**Capacitors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | | | | S/N Range |
|---|---|---|---|---|---|---|
| C256 | 281-576 | 11 pf | Cer | 500 v | 5% | 100-499X |
| C256 | 281-0578-00 | 18 pf | Cer | 500 v | 5% | X500-up |
| C257 | 281-0578-00 | 18 pf | Cer | 500 v | 5% | X500-up |
| C265 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C267 | 283-026 | 0.2 μf | Cer | 25 v | | |
| C276 | 290-187 | 4.7 μf | EMT | 35 v | | 100-499 |
| C276 | 290-0175-00 | 10 μf | EMT | 35 v | | 500-up |
| C278 | 283-003 | 0.01 μf | Cer | 150 v | | |
| C283 | 281-524 | 150 pf | Cer | 500 v | | |
| C290A | 281-007 | 3-12 pf | Cer Var | | | |
| C290B | 281-007 | 3-12 pf | Cer Var | | | |
| C290C | 281-010 | 4.5-25 pf | Cer Var | | | |
| C290D | 281-574 | 82 pf | Cer | 500 v | 10% | |
| C290E | *295-073 | 0.001 μf | Timing Series | | | 100-479 |
| C290F | | 0.01 μf | | | | |
| C290G | | 0.1 μf | | | | |
| C290H | | 1 μf | | | | |
| C290J | | 10 μf | | | | |
| C290E | *295-0104-00 | 0.001 μf | Timing Series | | | 480-up |
| C290F | | 0.01 μf | | | | |
| C290G | | 0.1 μf | | | | |
| C290H | | 1 μf | | | | |
| C290J | | 10 μf | | | | |
| C292 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C294 | 281-528 | 82 pf | Cer | 500 v | 10% | |
| C296 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C299 | Use 281-010 | 4.5-25 pf | Cer Var | | | |
| C301 | 281-519 | 47 pf | Cer | 500 v | 10% | |
| C303 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C311 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C314 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C328 | 281-550 | 120 pf | Cer | 500 v | 10% | |
| C329 | 281-519 | 47 pf | Cer | 500 v | 10% | |
| C330A | 281-550 | 120 pf | Cer | 500 v | 10% | |
| C330B | 285-543 | 0.0022 μf | PTM | 400 v | | |
| C330C | 285-636 | 0.022 μf | PTM | 200 v | | |
| C330D | 285-633 | 0.22 μf | PTM | 100 v | 10% | |
| C330E | 285-576 | 1 μf | PTM | 100 v | 10% | |
| C337 | 281-523 | 100 pf | Cer | 350 v | | |
| C344 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C346 | 281-512 | 27 pf | Cer | 500 v | 10% | |
| C360 | 281-523 | 100 pf | Cer | 350 v | | |
| C365 | 281-543 | 270 pf | Cer | 500 v | 10% | |
| C369 | 281-546 | 330 pf | Cer | 500 v | 10% | |
| C370 | 281-605 | 200 pf | Cer | 500 v | | |
| C375 | 281-544 | 5.6 pf | Cer | 500 v | 10% | |
| C380 | 281-536 | 1000 pf | Cer | 500 v | 10% | X170-up |
| C382 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C392 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C397 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C398 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C399 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C406 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C412 | 285-572 | 0.1 μf | PTM | 200 v | | |
| C424 | 283-000 | 0.001 μf | Cer | 500 v | | |

**Capacitors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | | | | S/N Range |
|---|---|---|---|---|---|---|
| C426 | 281-523 | 100 pf | Cer | 350 v | | |
| C428 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C436 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C438 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C439 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C503A | 281-558 | 18 pf | Cer | 500 v | | |
| C503C | 281-012 | 7-45 pf | Cer Var | | | |
| C503D | 281-560 | 198 pf | Cer | 500 v | | |
| C516 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C524 | 281-010 | 4.5-25 pf | Cer Var | | | |
| C525 | 281-557 | 1.8 pf | Cer | 500 v | | |
| C538 | 281-549 | 68 pf | Cer | 500 v | 10% | |
| C541 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C544 | 281-549 | 68 pf | Cer | 500 v | 10% | |
| C550 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C557D | 281-009 | 3-12 pf | Cer Var | | | |
| C557F | 281-013 | 8-50 pf | Cer Var | | | |
| C557H | 281-013 | 8-50 pf | Cer Var | | | |
| C562 | 290-0214-00 | 10 μf | EMT | 250 v | | X470-up |
| C572 | 281-022 | 8-50 pf | Cer Var | | | |
| C574 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C576 | 281-053 | 0.35-1.37 pf | Poly Var | | | |
| C579 | 283-068 | 0.01 μf | Cer | 500 v | | |
| C582 | 281-022 | 8-50 pf | Cer Var | | | |
| C584 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C586 | 281-053 | 0.35-1.37 pf | Poly Var | | | |
| C589 | 283-068 | 0.01 μf | Cer | 500 v | | |
| C591 | 281-036 | 3-12 pf | Cer Var | | | |
| C592 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C598 | 285-628 | 0.033 μf | PTM | 300 v | | |
| C599 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C600 | 285-519 | 0.047 μf | PTM | 400 v | | |
| C610 | 285-510 | 0.01 μf | PTM | 400 v | | |
| C617 | 285-519 | 0.047 μf | PTM | 400 v | | |
| C628 | 285-510 | 0.01 μf | PTM | 400 v | | |
| C636 | 281-519 | 47 pf | Cer | 500 v | 10% | |
| C640 | 283-022 | 0.02 μf | Cer | 1400 v | | |
| C642A,B | Use 290-197 | 250 μf/40 μf | EMC | 350 v/250 v | | |
| C650 | 285-510 | 0.01 μf | PTM | 400 v | | |
| C665 | 283-0001-00 | 0.005 μf | Cer | 500 v | | X170-up |
| C670 | 283-022 | 0.02 μf | Cer | 1400 v | | |
| C671 | Use 290-180 | 300 μf | EMC | 250 v | | |
| C680 | 285-510 | 0.01 μf | PTM | 400 v | | |
| C688 | 285-510 | 0.01 μf | PTM | 400 v | | |
| C694 | 281-523 | 100 pf | Cer | 350 v | | |
| C701 | Use 290-192 | 200 μf | EMC | 400 v | | |
| C709A | Use 290-195 | 10 μf | EMC | 450 v | | |
| C709B | | 10 μf | | 350 v | | |
| C709C | | 20 μf | | 250 v | | |

**Capacitors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | S/N Range |
|---|---|---|---|---|---|---|
| C710 | 285-511 | 0.01 μf | PTM | 600 v | 10% | |
| C730 | Use 290-179 | 125 μf | EMC | 250 v | | |
| C754 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C756 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C760 | 281-549 | 68 pf | Cer | 500 v | 10% | |
| C765 | 281-505 | 12 pf | Cer | 500 v | 10% | |
| C767 | 283-003 | 0.01 μf | Cer | 150 v | | |
| C768 | 281-604 | 2.2 pf | Cer | 500 v | ±0.25 pf | |
| C769 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C770 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C771 | Use 290-185 | 2 x 40 μf | EMC | 250 v | | |
| C772 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C773A | Use 290-196 | 40 μf | EMC | 250 v | | |
| C773B | | 20 μf | | 350 v | | |
| C773C | | 20 μf | | 450 v | | |
| C774 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C775 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C777 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C802 | Use 290-190 | 40 μf | EMC | 400 v | | |
| C803 | 283-000 | 0.001 μf | Cer | 500 v | | |
| C806 | 285-506 | 0.0047 μf | PTM | 400 v | | |
| C808 | 285-502 | 0.001 μf | PTM | 1000 v | | |
| C820 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C821 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C822 | 281-525 | 470 pf | Cer | 500 v | | |
| C823 | 283-101 | 0.0047 μf | Cer | 6000 v | | |
| C828 | 281-536 | 0.001 μf | Cer | 500 v | 10% | |
| C829 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C830 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C832 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C833 | 281-556 | 500 pf | Cer | 10000 v | | |
| C834 | 281-556 | 500 pf | Cer | 10000 v | | |
| C835 | 281-511 | 22 pf | Cer | 500 v | 10% | |
| C836 | 283-096 | 500 pf | Cer | 20000 v | | |
| C841 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C842 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C852 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C854 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C858 | 283-082 | 0.01 μf | Cer | 4000 v | | |
| C863 | 283-002 | 0.01 μf | Cer | 500 v | | |
| C932 | 283-041 | 0.0033 μf | Cer | 500 v | 5% | |
| C934 | 283-032 | 470 pf | Cer | 500 v | 5% | |
| C939 | 283-057 | 0.1 μf | Cer | 200 v | | |
| C941 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C944 | 283-057 | 0.1 μf | Cer | 200 v | | |

**Capacitors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| C958 | 281-525 | 470 pf | Cer | | 500 v | | |
| C965 | 281-523 | 100 pf | Cer | | 350 v | | |
| C1000 | 281-601 | 7.5 pf | Cer | | 500 v | ±0.5 pf | |
| C1002 | 283-001 | 0.005 μf | Cer | | 500 v | | |
| C1014 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | |
| C1016 | 281-519 | 47 pf | Cer | | 500 v | 10% | |
| C1019 | Use 281-0505-00 | 12 pf | Cer | | 500 v | | X170-up |
| C1024 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | |
| C1026 | 281-519 | 47 pf | Cer | | 500 v | 10% | |
| C1027 | 281-558 | 18 pf | Cer | | 500 v | | 100-469 |
| C1027 | 281-0061-00 | 5.5-18 pF | Cer | Var | | | 470-up |
| C1028 | 283-001 | 0.005 μf | Cer | | 500 v | | |
| C1029 | 281-006 | 1.5-7 pf | Cer | Var | | | |
| C1031 | 281-572 | 6.7 pf | Cer | | 500 v | ±0.5 pf | |
| C1035 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1035 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1038 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1038 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1042 | 281-572 | 6.8 pf | Cer | | 500 v | ±0.5 pf | |
| C1048 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1048 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1069 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1069 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1071 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1071 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1074 | 281-503 | 8 pf | Cer | | 500 v | ±0.5 pf | |
| C1076 | 281-075 | 5-25 pf | Cer | Var | | | |
| C1077 | 281-549 | 68 pf | Cer | | 500 v | 10% | |
| C1087 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1087 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1103 | 281-511 | 22 pf | Cer | | 500 v | 10% | |
| C1104 | 281-524 | 150 pf | Cer | | 500 v | | |
| C1105 | 281-075 | 5-25 pf | Cer | Var | | | |
| C1106 | 281-075 | 5-25 pf | Cer | Var | | | |
| C1107 | 281-600 | 35 pf | Cer | | | 10% | |
| C1113 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1113 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1116 | 283-001 | 0.005 μf | Cer | | 500 v | | |
| C1124 | 281-524 | 150 pf | Cer | | 500 v | | |
| C1126 | 281-075 | 5-25 pf | Cer | Var | | | |
| C1127 | 281-558 | 18 pf | Cer | | 500 v | | |
| C1132 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | 100-301 |
| C1132 | 283-0078-00 | 0.001 μf | Cer | | 500 v | | 302-up |
| C1142 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | |
| C1152 | 283-067 | 0.001 μf | Cer | | 200 v | 10% | |



©

## Capacitors *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | | | | S/N Range |
|---|---|---|---|---|---|---|
| C1153 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C1157 | Use 283-057 | 0.1 μf | Cer | 200 v | | |
| C1161 | 283-001 | 0.005 μf | Cer | 500 v | | |
| C1163 | 283-006 | 0.02 μf | Cer | 600 v | | |
| C1165 | 281-0512-00 | 27 pf | Cer | 500 v | 10% | X500-up |
| C1175 | 281-0512-00 | 27 pf | Cer | 500 v | 10% | X500-up |
| C1181 | 283-067 | 0.001 μf | Cer | 200 v | 10% | |
| C1191 | 283-067 | 0.001 μf | Cer | 200 v | | |

## Connector

| | | | |
|---|---|---|---|
| J11 | 131-018 | 16 contact, female, chassis mounted | |

## Diodes

| | | | | |
|---|---|---|---|---|
| D21 | *152-0075-00 | Germanium Tek Spec | | X500-up |
| D22 | *152-0075-00 | Germanium Tek Spec | | X500-up |
| D45 | 152-154 | Tunnel TD253 | 10MA | |
| D57 | *152-075 | Germanium Tek Spec | | |
| D59 | *152-075 | Germanium Tek Spec | | |
| D69 | 152-141 | Silicon 1N3605 | | |
| D71 | 152-141 | Silicon 1N3605 | | |
| D76 | 152-119 | Zener 1N969A | .4 w, 22 v, 10% | |
| D79 | 152-141 | Silicon 1N3605 | | |
| D83 | *152-075 | Germanium Tek Spec | | |
| D85 | Use *152-125 | Tunnel Selected TD3A | 4.7 MA | |
| D86 | *152-161 | Tek GaAs | | |
| D90 | *152-0165-00 | Silicon Selected from 1N3579 | | X199-up |
| D97 | 152-118 | Zener 1N3033 | 1 w, 36 v 20% | |
| D98 | *152-061 | Silicon Tek Spec | | |
| D100 | *152-061 | Silicon Tek Spec | | |
| D129 | *152-061 | Silicon Tek Spec | | |
| D132 | *152-061 | Silicon Tek Spec | | |
| D147 | 152-141 | Silicon 1N3605 | | |
| D163 | 152-141 | Silicon 1N3605 | | |
| D164 | *152-075 | Germanium Tek Spec | | |
| D172 | *152-061 | Silicon Tek Spec | | |
| D194 | *152-061 | Silicon Tek Spec | | X170-up |
| D221 | *152-0075-00 | Germanium Tek Spec | | X500-up |
| D222 | *152-0075-00 | Germanium Tek Spec | | X500-up |
| D245 | 152-154 | Tunnel TD253 | 10 MA | |
| D257 | *152-075 | Germanium Tek Spec | | |
| D259 | *152-075 | Germanium Tek Spec | | |
| D265 | 152-008 | Germanium | | |
| D269 | 152-141 | Silicon 1N3605 | | |

## Diodes *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | | S/N Range |
|---|---|---|---|---|
| D271 | 152-141 | Silicon 1N3605 | | |
| D277 | 152-119 | Zener 1N969A | .4 w, 22 v, 10% | |
| D279 | 152-141 | Silicon 1N3605 | | |
| D283 | *152-075 | Germanium Tek Spec | | |
| D285 | Use *152-125 | Tunnel Selected TD3A | 4.7 MA | |
| D286 | *152-161 | Tek GaAs | | |
| D297 | 152-118 | Zener 1N3033 | 1 w, 36 v, 20% | |
| D298 | *152-061 | Silicon Tek Spec | | |
| D300 | *152-061 | Silicon Tek Spec | | |
| D329 | *152-061 | Silicon Tek Spec | | |
| D332 | *152-061 | Silicon Tek Spec | | |
| D347 | 152-141 | Silicon 1N3605 | | |
| D362 | 152-141 | Silicon 1N3605 | | |
| D363 | 152-141 | Silicon 1N3605 | | |
| D367 | 152-141 | Silicon 1N3605 | | |
| D372 | *152-061 | Silicon Tek Spec | | |
| D405 | Use 152-081 | Tunnel TD2 | 2.2 MA | |
| D433 | Use *152-061 | Silicon Tek Spec | | |
| D541 | 152-067 | Zener 1M25Z10 | 1 w, 25 v, 10% | |
| D542 | *152-075 | Germanium Tek Spec | | 100-469 |
| D542 | *152-0061-00 | Silicon Tek Spec | | 470-up |
| D561 | *152-075 | Germanium Tek Spec | | 100-469 |
| D561 | *152-0061-00 | Silicon Tek Spec | | 470-up |
| D582 | *152-061 | Silicon Tek Spec | | |
| D642A,B,C,D | 152-066 | Silicon 1N3194 | | |
| D672A,B,C,D, | *152-047 | Replaceable by 1N2862 | | 100-429 |
| D672A,B,C,D | 152-0066-00 | Silicon 1N3194 | | 430-up |
| D693 | 152-157 | Zener .4M140Z10 | .4 w, 140 V, 10% | 100-469 |
| D693 | 152-0288-00 | Zener .4M140Z5 | .4 w, 140 V, 5% | 470-519X |
| D694 | *152-0107-00 | Silicon Replaceable by 1N647 | | X520-up |
| D702A,B | 152-066 | Silicon 1N3194 | | |
| D732A,B | 152-066 | Silicon 1N3194 | | |
| D759 | 152-141 | Silicon 1N3605 | | |
| D769 | *152-061 | Silicon Tek Spec | | |
| D803 | *152-0107-00 | Silicon Replaceable by 1N647 | | X470-up |
| D804 | 152-0265-00 | Zener 1N970B | .4 w, 24 v, 5% | X470-up |
| D831 | 152-208 | Silicon 1N3195 | | 170-539 |
| D831 | 152-0040-00 | Silicon 1N2615 | | 540-up |
| D942 | *152-061 | Silicon Tek Spec | | |
| D948 | 152-004 | Zener 1N707 or 1N763 | ¼ w, 6.2 v-8 v | 100-199X |
| D1014 | 152-141 | Silicon 1N3605 | | |
| D1018 | 152-120 | Zener 1N3020B | 1 w, 10,v 5% | |
| D1024 | 152-141 | Silicon 1N3605 | | |
| D1109 | 152-0228-00 | Zener ¾ M 105Z10 | 1 w, 105 v, 10% | X170-up |

## Fuses

| | | |
|---|---|---|
| F601 | 159-011 | 6.25 Amp 3AG Slo-Blo, 115 v, 50-60 and 400 cps |
| | 159-005 | 3 Amp 3AG Slo-Blo, 230 v, 50-60 and 400 cps |

## Inductors

| Ckt. No. | Tektronix Part No. | Description | S/N Range |
|---|---|---|---|
| LR21 | *108-230 | 3.25 μh on 150 Ω ½ w 5% resistor | |
| LR23 | *108-230 | 3.25 μh on 150 Ω ½ w 5% resistor | |
| L44 | 276-507 | Core, Ferramic Suppressor | 100-499X |
| L50 | *108-0146-00 | 5 μh | X500-up |
| L52 | *108-147 | 2.2 μh | 100-499X |
| L56 | *108-215 | 1.1 μh | |
| L85 | *108-0410-00 | 1 μh | X500-up |
| LR221 | *108-230 | 3.25 μh on 150 Ω ½ w 5% resistor | |
| LR223 | *108-230 | 3.25 μh on 150 Ω ½ w 5% resistor | |
| L244 | 276-507 | Core, Ferramic Suppressor | 100-499X |
| L250 | *108-0146-00 | 5 μh | X500-up |
| L252 | *108-147 | 2.2 μh | 100-499X |
| L256 | *108-215 | 1.1 μh | |
| L285 | *108-0410-00 | 1 μh | X500-up |
| L404 | *120-309 | Toroid, 6T Single | |
| L553 | *119-030 | Delay Line Assembly | |
| L760 | 108-240 | 820 μh | |
| L778 | Use *108-323 | Beam Rotator | |
| L1013 | *108-260 | 0.1 μh | |
| L1018 | *120-266 | Toroid, 10T Single | |
| L1023 | *108-260 | 0.1 μh | |
| L1030 | *108-264 | 0.2 μh | |
| L1040 | *108-264 | 0.2 μh | |
| L1051 | *108-260 | 0.1 μh | |
| LR1052 | *108-288 | 1.2 μh on 6.2 Ω ½ w 5% resistor | |
| L1061 | *108-260 | 0.1 μh | |
| LR1062 | *108-288 | 1.2 μh on 6.2 Ω ½ w 5% resistor | |
| L1072 | *108-260 | 0.1 μh | |
| L1082 | *108-260 | 0.1 μh | |
| LR1115 | *131-353 | 0.5 μh on 330 Ω ¼ w resistor (brown) | |
| LR1135 | *131-354 | 0.5 μh on 330 Ω ¼ w resistor (blue) | |
| L1144 | *108-095 | 1.4 μh | |
| L1154 | *108-095 | 1.4 μh | |
| L1157 | *114-080 | 6.8 μh-14.6 μh Var Core 276-506 | |
| L1160 | 276-528 | Core, Ferramic Suppressor | |
| L1170 | 276-528 | Core, Ferramic Suppressor | |

## Relays

| | | | |
|---|---|---|---|
| K600 | 148-021 | Tube Relay | |
| K601 | *148-019 | Tek Spec | |

## Transistors

| | | | |
|---|---|---|---|
| Q34 | 151-089 | 2N962 | 100-479 |
| Q34 | 151-0188-00 | 2N3906 | 480-499 |
| Q34 | *151-0199-00 | Silicon Replaceable by MPS-3640 | 500-up |
| Q44 | 151-089 | 2N962 | 100-479 |
| Q44 | 151-0188-00 | 2N3906 | 480-499 |

**Transistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | S/N Range |
|---|---|---|---|
| Q44 | *151-0199-00 | Silicon Replaceable by MPS-3640 | 500-up |
| Q65 | *151-108 | Replaceable by 2N2501 | |
| Q75 | *151-108 | Replaceable by 2N2501 | |
| Q84 | *151-108 | Replaceable by 2N2501 | |
| Q89 | *151-096 | Selected from 2N1893 | |
| Q103 | 151-089 | 2N962 | 100-479 |
| Q103 | 151-0188-00 | 2N3906 | 480-up |
| Q173 | 151-063 | 2N2207 | |
| Q234 | 151-089 | 2N962 | 100-479 |
| Q234 | 151-0188-00 | 2N3906 | 480-499 |
| Q234 | *151-0199-00 | Silicon Replaceable by MPS-3640 | 500-up |
| Q244 | 151-089 | 2N962 | 100-479 |
| Q244 | 151-0188-00 | 2N3906 | 480-499 |
| Q244 | *151-0199-00 | Silicon Replaceable by MPS-3640 | 500-up |
| Q265 | *151-108 | Replaceable by 2N2501 | |
| Q275 | *151-108 | Replaceable by 2N2501 | |
| Q284 | *151-108 | Replaceable by 2N2501 | |
| Q289 | *151-096 | Selected from 2N1893 | |
| Q303 | 151-089 | 2N962 | 100-479 |
| Q303 | 151-0188-00 | 2N3906 | 480-up |
| Q373 | 151-063 | 2N2207 | |
| Q424 | 151-063 | 2N2207 | |
| Q433 | *151-103 | Replaceable by 2N2219 | |
| Q534 | *151-121 | Selected from TA1938 | |
| Q543 | *151-096 | Selected from 2N1893 | |
| Q554 | 151-063 | 2N2207 | |
| Q564 | 151-063 | 2N2207 | |
| Q1014, Q1024 | *153-525 | Matched pair (Selected from 2N2475) | |
| Q1034, Q1044 | *153-527 | Matched pair (Replaceable by 2N2501) | |
| Q1074, Q1084 | *153-525 | Matched pair (Selected from 2N2475) | |
| Q1104† | *153-526 | Selected from 2N2369 | |
| Q1109 | 151-0149-00 | 2N3441 | X170-up |
| Q1114†† | *153-524 | Selected from TA1938 | 100-469 |
| Q1114†† | *153-0548-00 | Selected from 2N3119 | 470-up |
| Q1124† | *153-526 | Selected from 2N2369 | |
| Q1134†† | *153-524 | Selected from TA1938 | 100-469 |
| Q1134†† | *153-0548-00 | Selected from 2N3119 | 470-up |
| Q1144, Q1154 | *153-527 | Matched pair (Replaceable by 2N2501) | |
| Q1163 | *151-127 | Selected from 2N2369 | |
| Q1173 | *151-127 | Selected from 2N2369 | |

†Q1104 and Q1124 furnished as a matched pair.

††Q1114 and Q1134 furnished as a matched pair.

## Resistors

| Ckt. No. | Tektronix Part No. | Description | | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| Resistors are fixed, composition, ±10% unless otherwise indicated. | | | | | | | |
| R5 | 302-104 | 100 k | ½ w | | | | |
| R6 | 321-385 | 100 k | ⅛ w | | Prec | 1% | |
| R7 | 323-406 | 165 k | ½ w | | Prec | 1% | |
| R8 | 316-101 | 100 Ω | ¼ w | | | | |
| R9 | 311-018 | 20 k | | Var | | B INT TRIG DC LEVEL | |
| R13 | 323-481 | 1 meg | ½ w | | Prec | 1% | |
| R14 | 302-155 | 1.5 meg | ½ w | | | | |
| R15††† | 311-426 | 300 k | | Var | | B TRIGGERING LEVEL | |
| R16 | 302-394 | 390 k | ½ w | | | | |
| R17 | 302-335 | 3.3 meg | ½ w | | | | |
| R18 | 302-104 | 100 k | ½ w | | | | |
| R19 | 316-105 | 1 meg | ¼ w | | | | |
| R20 | 316-101 | 100 Ω | ¼ w | | | | |
| R21 | 316-221 | 220 Ω | ¼ w | | | | 100-499 |
| R21 | 315-0471-00 | 470 Ω | ¼ w | | | 5% | 500-up |
| R22 | 316-101 | 100 Ω | ¼ w | | | | |
| R23 | 316-221 | 220 Ω | ¼ w | | | | 100-499 |
| R23 | 315-0471-00 | 470 Ω | ¼ w | | | 5% | 500-up |
| R24 | 308-108 | 15 k | 5 w | | WW | 5% | |
| R25 | 311-158 | 200 Ω | | Var | | B TRIGGER LEVEL CENTERING | |
| R27 | 308-267 | 7.5 k | 5 w | | WW | 5% | |
| R28 | 302-102 | 1 k | ½ w | | | | |
| R32 | 315-0471-00 | 470 Ω | ¼ w | | | 5% | X500-up |
| R33 | 308-0301-00 | 10 k | 3 w | | WW | 1% | X500-up |
| R36 | 324-335 | 30.1 k | 1 w | | Prec | 1% | 100-499 |
| R36 | 308-0320-00 | 15.6 k | 3 w | | WW | 1% | 500-up |
| R41 | 316-221 | 220 Ω | ¼ w | | | | 100-499X |
| R42 | 315-0471-00 | 470 Ω | ¼ w | | | 5% | X500-up |
| R43 | 316-100 | 10 Ω | ¼ w | | | | 100-499X |
| R44 | 322-001 | 10 Ω | ¼ w | | Prec | 1% | 100-499X |
| R45 | 311-324 | 50 Ω | ½ w | Var | WW | B TRIGGER SENS | 100-499 |
| R45 | 311-0405-00 | 10 k | | Var | | B TRIGGER SENS | 500-up |
| R46 | 308-0310-00 | 12 k | 5 w | | WW | 1% | X500-up |
| R47 | 324-306 | 15 k | 1 w | | Prec | 1% | 100-499X |
| R48 | 324-306 | 15 k | 1 w | | Prec | 1% | 100-499X |
| R49 | 302-101 | 100 Ω | ½ w | | | | |
| R50 | 302-101 | 100 Ω | ½ w | | | | |
| R51 | 302-101 | 100 Ω | ½ w | | | | |
| R52 | 315-0560-00 | 56 Ω | ¼ w | | | 5% | X500-up |
| R53 | 323-370 | 69.8 k | ½ w | | Prec | 1% | |
| R54 | 323-140 | 280 Ω | ½ w | | Prec | 1% | |

†††Furnished as a unit with SW15.

## Resistors *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | S/N Range |
|---|---|---|---|---|---|---|
| R56 | 316-102 | 1 k | ¼ w | | | |
| R57 | 302-224 | 220 k | ½ w | | | 100-499 |
| R57 | 302-0104-00 | 100 k | ½ w | | | 500-up |
| R63 | 316-470 | 47 Ω | ¼ w | | | |
| R65 | 301-303 | 30 k | ½ w | | 5% | |
| R67 | 301-912 | 9.1 k | ½ w | | 5% | |
| R69 | 302-103 | 10 k | ½ w | | | |
| R71 | 303-513 | 51 k | 1 w | | 5% | |
| R75 | 301-513 | 51 k | ½ w | | 5% | 100-499 |
| R75 | 303-0243-00 | 24 k | 1 w | | 5% | 500-up |
| R76 | 302-471 | 470 Ω | ½ w | | | 100-499 |
| R76 | 301-0221-00 | 220 Ω | ½ w | | 5% | 500-up |
| R78 | 301-752 | 7.5 k | ½ w | | 5% | |
| R79 | 302-152 | 1.5 k | ½ w | | | 100-499 |
| R79 | 302-0561-00 | 560 Ω | ½ w | | | 500-up |
| R81 | 316-101 | 100 Ω | ¼ w | | | 100-499 |
| R81 | 315-0181-00 | 180 Ω | ¼ w | | 5% | 500-up |
| R82 | 323-333 | 28.7 k | ½ w | Prec | 1% | 100-499 |
| R82 | 323-0636-00 | 50 k | ½ w | Prec | 1% | 500-up |
| R83 | 316-394 | 390 k | ¼ w | | | |
| R84 | 305-153 | 15 k | 2 w | | 5% | |
| R85 | 315-103 | 1 k | ¼ w | | 5% | |
| R86 | 303-513 | 51 k | 1 w | | 5% | |
| R87 | 315-273 | 27 k | ¼ w | | 5% | |
| R88 | 302-823 | 82 k | ½ w | | | |
| R89 | 302-105 | 1 meg | ½ w | | | |
| R90A | *312-640 | 140 k | ½ w | | 1% | |
| R90B | | 280 k | ½ w | | 1% | |
| R90C | | 700 k | ½ w | | 1% | |
| R90D | | 1.4 meg | ½ w | | 1% | |
| R90E | *312-641 | 2.8 meg | ½ w | | 1% | 100-469 |
| R90F | | 7 meg | ½ w | | 1% | |
| R90D | *312-0641-01 | 1.4 meg | ½ w | | | 470-up |
| R90E | | 2.8 meg | ½ w | | | |
| R90F | | 7 meg | ½ w | | | |
| R90G | | 47 k | (nominal value) Selected | | | |
| R90K | 302-271 | 270 Ω | ½ w | | | |
| R90W | 302-105 | 1 meg | ½ w | | | |
| R90X | 302-104 | 100 k | ½ w | | | |
| R90Y | 301-392 | 3.9 k | ½ w | | 5% | |
| R90Z† | 311-391 | 150 k | | Var | B VARIABLE | |
| R92 | 316-101 | 100 Ω | ¼ w | | | |
| R93 | 304-473 | 47 k | 1 w | | | |
| R94 | 304-473 | 47 k | 1 w | | | |
| R95 | 316-101 | 100 Ω | ¼ w | | | |
| R96 | 316-101 | 100 Ω | ¼ w | | | |
| R98 | 315-303 | 30 k | ¼ w | | 5% | |

†Furnished as a unit with SW90Z.

**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | | | | S/N Range |
|---|---|---|---|---|---|---|
| R99 | 323-356 | 49.9 k | ½ w | | Prec | 1% |
| R100 | 316-272 | 2.7 k | ¼ w | | | |
| R101 | 316-122 | 1.2 k | ¼ w | | | |
| R102 | 316-153 | 15 k | ¼ w | | | |
| R103 | 306-273 | 27 k | 2 w | | | |
| R105 | 302-152 | 1.5 k | ½ w | | | |
| R121 | 306-683 | 68 k | 2 w | | | |
| R124 | 303-163 | 16 k | 1 w | | | 5% |
| R125 | 311-011 | 5 k | | Var | | B SWEEP LENGTH |
| R126 | 305-393 | 39 k | 2 w | | | 5% |
| R128 | 302-102 | 1 k | ½ w | | | 5% |
| R129 | 302-562 | 5.6 k | ½ w | | | |
| R130A | 302-155 | 1.5 meg | ½ w | | | |
| R130C | 301-156 | 15 meg | ½ w | | | 5% |
| R137 | 323-481 | 1 meg | ½ w | | Prec | 1% |
| R138 | 309-439 | 5.9 meg | ½ w | | Prec | 1% |
| R139 | 316-101 | 100 Ω | ¼ w | | | |
| R141 | 301-334 | 330 k | ½ w | | | 5% |
| R142 | 301-274 | 270 k | ½ w | | | 5% |
| R143 | 301-683 | 68 k | ½ w | | | 5% |
| R144 | 302-101 | 100 Ω | ½ w | | | |
| R145 | 323-302 | 13.7k | ½ w | | Prec | 1% |
| R146 | 323-385 | 100 k | ½ w | | Prec | 1% |
| R147 | 323-402 | 150 k | ½ w | | Prec | 1% |
| R148 | 316-101 | 100 Ω | ¼ w | | | |
| R149 | 302-122 | 1.2 k | ½ w | | | |
| R162 | 323-243 | 3.32 k | ½ w | | Prec | 1% |
| R163 | 308-268 | 22 k | 5 w | | WW | 1% |
| R164 | 324-339 | 33.2 k | 1 w | | Prec | 1% |
| R165 | 301-183 | 18 k | ½ w | | | 5% |
| R166 | 301-134 | 130 k | ½ w | | | 5% |
| R170 | 315-472 | 4.7 k | ¼ w | | | 5% |
| R171 | 302-472 | 4.7 k | ½ w | | | |
| R172 | 302-274 | 270 k | ½ w | | | |
| R173 | 316-101 | 100 Ω | ¼ w | | | |
| R176 | 316-270 | 27 Ω | ¼ w | | | |
| R180 | 323-353 | 46.4 k | ½ w | | Prec | 1% |
| R181 | 323-330 | 26.7 k | ½ w | | Prec | 1% |
| R182 | 323-356 | 49.9 k | ½ w | | Prec | 1% |
| R184 | 323-469 | 750 k | ½ w | | Prec | 1% |
| R186 | 309-448 | 9.31 meg | ½ w | | Prec | 1% |
| R187 | 309-447 | 6.19 meg | ½ w | | Prec | 1% |
| R188 | 316-100 | 10 Ω | ¼ w | | | |
| R189 | 311-419 | 500 k | | Var | | BRIGHTNESS |
| R190 | 316-101 | 100 Ω | ¼ w | | | |

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**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R191 | 316-470 | 47 Ω | ¼ w | | | | |
| R192 | 316-101 | 100 Ω | ¼ w | | | | |
| R193 | 302-104 | 100 k | ½ w | | | | |
| R194 | 316-820 | 82 Ω | ¼ w | | | | |
| R195 | 323-373 | 75 k | ½ w | | Prec | 1% | |
| R196 | 316-470 | 47 Ω | ¼ w | | | | |
| R197 | 316-101 | 100 Ω | ¼ w | | | | |
| R198 | 302-472 | 47 k | ½ w | | | | |
| R199 | 302-103 | 10 k | ½ w | | | | |
| R205 | 302-104 | 100 k | ½ w | | Prec | 1% | |
| R206 | 321-385 | 100 k | ⅛ w | | | | |
| R207 | 323-406 | 165 k | ½ w | | Prec | 1% | |
| R209 | 311-018 | 20 k | | Var | | A INT TRIG DC LEVEL | |
| R210 | 316-103 | 10 k | ¼ w | | | | |
| R211 | 316-222 | 2.2 k | ¼ w | | | | |
| R213 | 323-481 | 1 meg | ¼ w | | Prec | 1% | |
| R214 | 302-155 | 1.5 meg | ½ w | | | | |
| R215† | 311-426 | 300 k | | Var | | A TRIGGERING LEVEL | |
| R216 | 302-394 | 390 k | ½ w | | | | |
| R217 | 302-335 | 3.3 meg | ½ w | | | | |
| R218 | 302-104 | 100 k | ½ w | | | | |
| R219 | 316-105 | 1 meg | ¼ w | | | | |
| R220 | Use 316-0101-00 | 100 Ω | ¼ w | | | | |
| R221 | 316-221 | 220 Ω | ¼ w | | | | 100-499 |
| R221 | 315-0471-00 | 470 Ω | ¼ w | | | 5% | 500-up |
| R222 | Use 316-0101-00 | 100 Ω | ¼ w | | | | |
| R223 | 316-221 | 220 Ω | ¼ w | | | | 100-499 |
| R223 | 315-0471-00 | 470 Ω | ¼ w | | | 5 % | 500-up |
| R224 | 308-108 | 15 k | 5 w | | WW | 5% | |
| R225 | 311-004 | 200 Ω | | Var | | A TRIGGER LEVEL CENTERING | |
| R227 | 308-267 | 7.5 k | 5 w | | WW | 5% | |
| R228 | 302-102 | 1 k | ½ w | | | | |
| R232 | 315-0471-00 | 470 Ω | ¼ w | | | 5% | X500-up |
| R233 | 308-0301-00 | 10 k | 3 w | | WW | 1% | X500-up |
| R236 | 324-335 | 30.1 k | 1 w | | Prec | 1% | 100-499 |
| R236 | 308-0320-00 | 15.6 k | 3 w | | WW | 1% | 500-up |
| R241 | 316-221 | 220 Ω | ¼ w | | | | 100-499X |
| R242 | 315-0471-00 | 470 Ω | ¼ w | | | 5% | X500-up |
| R243 | 316-100 | 10 Ω | ¼ w | | | | 100-499X |
| R244 | 323-001 | 10 Ω | ½ w | | Prec | 1% | 100-499X |
| R245 | 311-308 | 50 Ω | 2 w | Var | | A TRIGGER SENS | 100-499 |
| R245 | 311-0076-00 | 10 k | | Var | | A TRIGGER SENS | 500-up |
| R246 | 308-0310-00 | 12 k | 5 w | | WW | 1% | X500-up |
| R247 | 324-306 | 15 k | 1 w | | Prec | 1% | 100-499X |
| R248 | 324-306 | 15 k | 1 w | | Prec | 1% | 100-499X |

† Furnished as a unit with SW215.



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**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R249 | 302-101 | 100 Ω | ½ w | | | | |
| R252 | 315-0560-00 | 56 Ω | ¼ w | | | 5% | X500-up |
| R253 | 323-370 | 69.8 k | ½ w | | Prec | 1% | |
| R254 | 323-140 | 280 Ω | ½ w | | Prec | 1% | |
| R255 | 301-203 | 20 k | ½ w | | | 5% | |
| R256 | 301-134 | 130 k | ½ w | | | 5% | 100-499 |
| R256 | 301-0304-00 | 300 k | ½ w | | | 5% | 500-up |
| R258 | 302-473 | 47 k | ½ w | | | | |
| R263 | 316-470 | 47 Ω | ¼ w | | | | |
| R265 | 301-303 | 30 k | ½ w | | | 5% | |
| R267 | 301-912 | 9.1 k | ½ w | | | 5% | |
| R269 | 302-103 | 10 k | ½ w | | | | |
| R271 | 303-513 | 51 k | 1 w | | | 5% | |
| R275 | 301-513 | 51 k | ½ w | | | 5% | 100-499 |
| R275 | 303-0243-00 | 24 k | 1 w | | | 5% | 500-up |
| R276 | 302-471 | 470 Ω | ½ w | | | | 100-499 |
| R276 | 301-0221-00 | 220 Ω | ½ w | | | 5% | 500-up |
| R278 | 301-752 | 7.5 k | ½ w | | | 5% | |
| R279 | 302-152 | 1.5 k | ½ w | | | | 100-499 |
| R279 | 302-0561-00 | 560 Ω | ½ w | | | | 500-up |
| R281 | 316-101 | 100 Ω | ¼ w | | | | 100-499 |
| R281 | 315-0181-00 | 180 Ω | ¼ w | | | 5% | 500-up |
| R282 | 323-333 | 28.7 k | ½ w | | Prec | 1% | 100-499 |
| R282 | 323-0636-00 | 50 k | ½ w | | Prec | 1% | 500-up |
| R283 | 316-394 | 390 k | ¼ w | | | | |
| R284 | 305-153 | 15 k | 2 w | | | 5% | |
| R285 | 301-102 | 1 k | ½ w | | | 5% | |
| R286 | 303-513 | 51 k | 1 w | | | 5% | |
| R287 | 301-273 | 27 k | ½ w | | | 5% | |
| R288 | 302-823 | 82 k | ½ w | | | | |
| R289 | 302-105 | 1 meg | ½ w | | | | |
| R290A | *312-640 | 140 k | ½ w | | | 1% | |
| R290B | | 280 k | ½ w | | | 1% | |
| R290C | | 700 k | ½ w | | | 1% | |
| R290D | | 1.4 meg | ½ w | | | 1% | |
| R290E | *312-641 | 2.8 meg | ½ w | | | 1% | 100-469 |
| R290F | | 7 meg | ½ w | | | 1% | |
| R290D | *312-0641-01 | 1.4 meg | ½ w | | | | 470-up |
| R290E | | 2.8 meg | ½ w | | | | |
| R290F | | 7 meg | ½ w | | | | |
| R290G | | 47 k | (nominal value) | Selected | | | |
| R290W | 302-105 | 1 meg | ½ w | | | | |
| R290X | 302-104 | 100 k | ½ w | | | | |
| R290Y | 311-388 | 7.5 k | | Var | WW | A SWEEP CAL | |
| R290Z† | 311-391 | 150 k | | Var | | A VARIABLE | |
| R292 | 316-101 | 100 Ω | ¼ w | | | | |
| R293 | 304-473 | 47 k | 1 w | | | | |

†Furnished as a unit with SW290Z.

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**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | S/N Range |
|---|---|---|---|---|---|---|
| R294 | 304-473 | 47 k | 1 w | | | |
| R295 | 316-101 | 100 Ω | ¼ w | | | |
| R296 | 316-101 | 100 Ω | ¼ w | | | |
| R299 | 323-356 | 49.9 k | ½ w | Prec | 1% | |
| R301 | 316-471 | 470 Ω | ¼ w | | | |
| R302 | 316-153 | 15 k | ¼ w | | | |
| R303 | 306-273 | 27 k | 2 w | | | |
| R305 | 316-152 | 1.5 k | ¼ w | | | |
| R310 | 301-272 | 2.7 k | ½ w | | 5% | |
| R311 | 302-104 | 100 k | ½ w | | | |
| R312 | 316-101 | 100 Ω | ¼ w | | | |
| R314 | 316-101 | 100 Ω | ¼ w | | | |
| R316 | 302-104 | 100 k | ½ w | | | |
| R321 | 306-683 | 68 k | 2 w | | | |
| R324 | 303-163 | 16 k | 1 w | | 5% | |
| R325 | 311-011 | 5 k | | Var | A SWEEP LENGTH | |
| R326 | 305-393 | 39 k | 2 w | | 5% | |
| R328 | 302-102 | 1 k | ½ w | | | |
| R329 | 302-562 | 5.6 k | ½ w | | | |
| R330A | 301-155 | 1.5 meg | ½ w | | 5% | |
| R330B | 301-565 | 5.6 meg | ½ w | | 5% | |
| R330C | 301-156 | 15 meg | ½ w | | 5% | |
| R330D | 301-226 | 22 meg | ½ w | | 5% | |
| R331 | 301-683 | 68 k | ½ w | | 5% | |
| R332 | 301-682 | 6.8 k | ½ w | | 5% | |
| R334 | 323-373 | 75 k | ½ w | Prec | 1% | |
| R335 | 323-273 | 6.81 k | ½ w | Prec | 1% | |
| R337 | 323-481 | 1 meg | ½ w | Prec | 1% | |
| R338 | 309-439 | 5.9 meg | ½ w | Prec | 1% | |
| R339 | 316-101 | 100 Ω | ¼ w | | | |
| R341 | 301-334 | 330 k | ½ w | | 5% | |
| R342 | 301-274 | 270 k | ½ w | | 5% | |
| R343 | 301-683 | 68 k | ½ w | | 5% | |
| R344 | 316-101 | 100 Ω | ¼ w | | | |
| R345 | 323-302 | 13.7 k | ½ w | Prec | 1% | |
| R346 | 323-385 | 100 k | ½ w | Prec | 1% | |
| R347 | 323-402 | 150 k | ½ w | Prec | 1% | |
| R348 | 316-101 | 100 Ω | ¼ w | | | |
| R349 | 302-122 | 1.2 k | ½ w | | | |
| R359 | 316-273 | 27 k | ¼ w | | | |
| R360 | 316-222 | 2.2 k | ¼ w | | | |
| R361 | 323-243 | 3.32 k | ½ w | Prec | 1% | |
| R362 | 308-302 | 20 k | 5 w | WW | 1% | |
| R363 | 324-339 | 33.2 k | 1 w | Prec | 1% | |
| R364 | 301-303 | 30 k | ½ w | | 5% | |

**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R365 | 301-274 | 270 k | ½ w | | | 5% | |
| R366 | 316-102 | 1 k | ¼ w | | | | |
| R367 | 316-182 | 1.8 k | ¼ w | | | | |
| R368 | 316-336 | 33 meg | ¼ w | | | | |
| R369 | 316-182 | 1.8 k | ¼ w | | | | |
| R370 | 301-472 | 4.7 k | ½ w | | | 5% | |
| R371 | 302-472 | 4.7 k | ½ w | | | | |
| R372 | 302-274 | 270 k | ½ w | | | | |
| R373 | 316-470 | 47 Ω | ¼ w | | | | |
| R374 | 323-353 | 46.4 k | ½ w | | Prec | 1% | |
| R375 | 323-330 | 26.7 k | ½ w | | Prec | 1% | |
| R376 | 323-356 | 49.9 k | ½ w | | Prec | 1% | |
| R380 | 302-473 | 47 k | ½ w | | | | X170-up |
| R381 | 316-470 | 47 Ω | ¼ w | | | | |
| R382 | 316-101 | 100 Ω | ¼ w | | | | |
| R383 | 302-104 | 100 k | ½ w | | | | |
| R384 | 316-820 | 82 Ω | ¼ w | | | | |
| R390 | 323-373 | 75 k | ½ w | | Prec | 1% | |
| R391 | 316-470 | 47 Ω | ¼ w | | | | |
| R392 | 316-101 | 100 Ω | ¼ w | | | | |
| R393 | 302-472 | 4.7 k | ½ w | | | | |
| R394 | 316-101 | 100 Ω | ¼ w | | | | |
| R397 | 307-106 | 4.7 Ω | ¼ w | | | 5% | |
| R398 | 316-101 | 100 Ω | ¼ w | | | | |
| R399 | 316-101 | 100 Ω | ¼ w | | | | |
| R401 | 316-101 | 100 Ω | ¼ w | | | | |
| R404 | 302-331 | 330 Ω | ½ w | | | | |
| R406 | 301-563 | 56 k | ½ w | | | 5% | |
| R407 | 301-913 | 91 k | ½ w | | | 5% | |
| R408 | 316-101 | 100 Ω | ¼ w | | | | |
| R409 | 303-183 | 18 k | 1 w | | | 5% | |
| R412 | 316-101 | 100 Ω | ¼ w | | | | |
| R413 | 316-473 | 47 k | ¼ w | | | | |
| R414 | 324-339 | 33.2 k | 1 w | | Prec | 1% | |
| R415 | 311-015 | 10 k | | Var | WW | DELAY STOP | |
| R416 | 311-022 | 30 k | | Var | | DELAY TIME MULTIPLIER 1-10 | |
| R417 | 302-331 | 330 k | ½ w | | | | |
| R418 | 311-141 | 2 k | | Var | WW | DELAY START | |
| R419 | 308-268 | 22 k | 5 w | | WW | 1% | |
| R421 | 316-101 | 100 Ω | ¼ w | | | | |
| R424 | 302-564 | 560 k | ½ w | | | | |
| R425 | 301-104 | 100 k | ½ w | | | 5% | |
| R426 | 301-223 | 22 k | ½ w | | | 5% | |
| R428 | 302-223 | 22 k | ½ w | | | | |
| R429 | 302-682 | 6.8 k | ½ w | | | | |

**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R430 | 302-333 | 33 k | ½ w | | | | |
| R431 | 302-151 | 150 Ω | ½ w | | | | |
| R432 | 316-470 | 47 Ω | ¼ w | | | | |
| R433 | 302-102 | 1 k | ½ w | | | | |
| R435 | 302-562 | 5.6 k | ½ w | | | | |
| R438 | 302-101 | 100 Ω | ½ w | | | | |
| R439 | 302-102 | 1 k | ½ w | | | | |
| R501 | 302-470 | 47 Ω | ½ w | | | | |
| R503C | 323-611 | 900 k | ½ w | | Prec | 1% | |
| R503D | 323-610 | 111 k | ½ w | | Prec | 1% | |
| R507 | 323-481 | 1 meg | ½ w | | Prec | 1% | |
| R508 | 316-102 | 1 k | ¼ w | | | | |
| R509 | 306-333 | 33 k | 2 w | | | | |
| R510 | 301-201 | 200 Ω | ½ w | | | 5% | |
| R511 | Use 311-491 | 10 k | | Var | | VAR 10-1 | |
| R512 | 306-333 | 33 k | 2 w | | | | |
| R514 | 316-101 | 100 Ω | ¼ w | | | | |
| R516 | 302-332 | 3.3 k | ½ w | | | | |
| R517 | 302-224 | 220 k | ½ w | | | | |
| R519 | 311-026 | 100 k | | Var | | EXT HORIZ DC BAL | |
| R522 | 305-183 | 18 k | 2 w | | | 5% | |
| R523 | 301-204 | 200 k | ½ w | | | 5% | |
| R524 | 323-356 | 49.9 k | ½ w | | Prec | 1% | |
| R525 | 301-565 | 5.6 meg | ½ w | | | 5% | |
| R526 | 302-101 | 100 Ω | ½ w | | | | |
| R530A | 311-431 | 50 k | | Var | | HORIZ POSITION | |
| R530B | | 50 k | | | | VERNIER | |
| R531 | 323-369 | 68.1 k | ½ w | | Prec | 1% | |
| R532 | 301-394 | 390 k | ½ w | | | 5% | |
| R533 | 323-452 | 499 k | ½ w | | Prec | 1% | |
| R534 | 304-123 | 12 k | 1 w | | | | |
| R535 | 316-390 | 39 Ω | ¼ w | | | | |
| R538 | 302-123 | 12 k | ½ w | | | | |
| R539 | 303-753 | 75 k | 1 w | | | 5% | |
| R540 | 304-822 | 8.2 k | 1 w | | | | |
| R542 | 301-303 | 30 k | ½ w | | | 5% | |
| R543 | 306-393 | 39 k | 2 w | | | | |
| R544 | 311-172 | 2.5 k | | Var | | X10 CAL | |
| R545 | 323-284 | 8.87 k | ½ w | | Prec | 1% | 100-469 |
| R545 | 323-0281-00 | 8.25 k | ½ w | | Prec | 1% | 470-up |
| R547 | 302-104 | 100 k | ½ w | | | | |
| R550 | 302-823 | 82 k | ½ w | | | | |
| R553 | 323-295 | 11.5 k | ½ w | | Prec | 1% | |
| R554 | 308-211 | 12 k | 5 w | | WW | 5% | |
| R556 | 323-252 | 4.12 k | ½ w | | Prec | 1% | |



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**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R557C | 323-662 | 4.28 k | 1/2 w | | Prec | 1% | |
| R557E | 323-196 | 1.07 k | 1/2 w | | Prec | 1% | |
| R557F | 301-182 | 1.8 k | 1/2 w | | | 5% | |
| R557G | 323-162 | 475 Ω | 1/2 w | | Prec | 1% | |
| R557H | 301-122 | 1.2 k | 1/2 w | | | 5% | |
| R558 | 302-104 | 100 k | 1/2 w | | | | |
| R561 | 302-104 | 100 k | 1/2 w | | | | |
| R562 | 302-0333-00 | 33 k | 1/2 w | | | | X470-up |
| R563 | 323-281 | 8.25 k | 1/2 w | | Prec | 1% | |
| R564 | 308-211 | 12 k | 5 w | | WW | 5% | |
| R566 | 311-066 | 500 Ω | .2 w | Var | | X1 CAL | |
| R568 | 302-473 | 47 k | 1/2 w | | | | |
| R569 | 311-026 | 100 k | | Var | | SWP/MAG REGIS | |
| R570 | 316-470 | 47 Ω | 1/4 w | | | | |
| R571 | 308-266 | 5 k | 5 w | | WW | 5% | |
| R572 | *310-600 | 18 k/4.5 k | 7 w | | WW | | |
| R573 | 316-470 | 47 Ω | 1/4 w | | | | |
| R574 | 316-470 | 47 Ω | 1/4 w | | | | |
| R576 | *310-601 | 30 k | 8 w | | WW | 1% | |
| R577 | 302-154 | 150 k | 1/2 w | | | | |
| R578 | 316-103 | 10 k | 1/4 w | | | | |
| R579 | 302-394 | 390 k | 1/2 w | | | | |
| R580 | 316-470 | 47 Ω | 1/4 w | | | | |
| R581 | 302-155 | 1.5 meg | 1/2 w | | | | |
| R582 | *310-611 | 18 k/3.7 k/800 Ω | 6 w | | WW | | |
| R583 | 316-470 | 47 Ω | 1/4 w | | | | |
| R584 | 316-470 | 47 Ω | 1/4 w | | | | |
| R585 | 306-224 | 220 k | 2 w | | | | |
| R586 | *310-601 | 30 k | 8 w | | WW | 1% | |
| R587 | 302-154 | 150 k | 1/2 w | | | | |
| R588 | 316-103 | 10 k | 1/4 w | | | | |
| R589 | 302-394 | 390 k | 1/2 w | | | | |
| R591 | 302-155 | 1.5 meg | 1/2 w | | | | |
| R592 | 302-102 | 1 k | 1/2 w | | | | |
| R594 | 302-104 | 100 k | 1/2 w | | | | |
| R595 | 302-563 | 56 k | 1/2 w | | | | |
| R597 | 316-470 | 47 Ω | 1/4 w | | | | |
| R598 | 304-103 | 10 k | 1 w | | | | |
| R599 | 302-473 | 47 k | 1/2 w | | | | |
| R601 | 308-229 | 4 k | 5 w | | WW | 5% | |
| R603 | 308-269 | 22 Ω | 3 w | | WW | 5% | |
| R605 | 311-377 | 25 Ω | | Var | | SCALE ILLUM | |
| R608 | 302-333 | 33 k | 1/2 w | | | | |
| R610 | 302-104 | 100 k | 1/2 w | | | | |
| R615 | 324-369 | 68.1 k | 1 w | | Prec | 1% | |
| R616 | 311-015 | 10 k | | Var | WW | —150 VOLTS | |
| R617 | 324-356 | 49.9 k | 1 w | | Prec | 1% | |
| R618 | 302-104 | 100 k | 1/2 w | | | | |
| R621 | 302-102 | 1 k | 1/2 w | | | | |
| R623 | 302-474 | 470 k | 1/2 w | | | | |
| R625 | 302-104 | 100 k | 1/2 w | | | | |
| R628 | 302-275 | 2.7 meg | 1/2 w | | | | |
| R629 | 302-275 | 2.7 meg | 1/2 w | | | | |
| R631 | 302-102 | 1 k | 1/2 w | | | | |
| R632 | 316-470 | 47 Ω | 1/4 w | | | | |

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**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | S/N Range |
|---|---|---|---|---|---|---|
| R634 | 302-105 | 1 meg | ½ w | | | |
| R635 | 304-153 | 15 k | 1 w | | | |
| R636 | 304-153 | 15 k | 1 w | | | |
| R637 | 302-684 | 680 k | ½ w | | | |
| R638 | 302-273 | 27 k | ½ w | | | |
| R639 | 302-683 | 68 k | ½ w | | | |
| R640 | 306-100 | 10 Ω | 2 w | | | |
| R641 | 306-100 | 10 Ω | 2 w | | | |
| R644 | 302-102 | 1 k | ½ w | | | |
| R645 | 316-470 | 47 Ω | ¼ w | | | |
| R646 | 308-040 | 1.5 k | 25 w | WW | | |
| R647 | 308-282 | 1.35 k | 25 w | WW | 5% | |
| R650 | 324-443 | 402 k | 1 w | Prec | 1% | |
| R651 | 324-458 | 576 k | 1 w | Prec | 1% | |
| R663 | Use 301-0185-00 | 1.8 meg | ½ w | | 5% | X170-up |
| R664 | 304-333 | 33 k | 1 w | | 5% | X170-up |
| R665 | 301-0225-00 | 2.2 meg | ½ w | | 5% | X170-up |
| R666 | 301-0226-00 | 22 meg | ½ w | | | 100-169 |
| R667 | 302-334 | 330 k | ½ w | | 5% | 170-up |
| R667 | 301-0304-00 | 300 k | ½ w | | | |
| R668 | 302-563 | 56 k | ½ w | | | |
| R669 | 302-393 | 39 k | ½ w | | | |
| R670A | 306-100 | 10 Ω | 2 w | | | |
| R670B | 306-100 | 10 Ω | 2 w | | | |
| R671 | 308-155 | 800 Ω | 25 w | WW | 5% | |
| R673 | 308-147 | 750 Ω | 25 w | WW | 5% | |
| R674 | 302-102 | 1 k | ½ w | | | |
| R675 | 303-470 | 47 Ω | 1 w | | 5% | |
| R676 | 303-470 | 47 Ω | 1 w | | 5% | |
| R677 | Use 308-0065-00 | 2 k | 25 w | WW | 5% | |
| R680 | 324-443 | 402 k | 1 w | Prec | 1% | |
| R681 | 324-601 | 264 k | 1 w | Prec | 1% | |
| R682 | 302-124 | 120 k | ½ w | | | |
| R683 | 302-102 | 1 k | ½ w | | | |
| R685 | 304-823 | 82 k | 1 w | | | |
| R686 | 302-184 | 180 k | ½ w | | | |
| R688 | 302-155 | 1.5 meg | ½ w | | | |
| R689 | 302-225 | 2.2 meg | ½ w | | | |
| R693 | 302-155 | 1.5 meg | ½ w | | | |
| R694 | 302-473 | 47 k | ½ w | | | |
| R697 | 302-824 | 820 k | ½ w | | | |
| R698 | 302-274 | 270 k | ½ w | | | |
| R699 | 302-473 | 47 k | ½ w | | | |
| R700 | 306-100 | 10 Ω | 2 w | | | |
| R701 | 306-100 | 10 Ω | 2 w | | | |

**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R703 | 303-470 | 47 Ω | 1 w | | | 5% | |
| R704 | 302-102 | 1 k | ½ w | | | | |
| R705 | 303-470 | 47 Ω | 1 w | | | 5% | |
| R706 | 308-282 | 1.35 k | 25 w | | WW | 5% | |
| R707 | 308-282 | 1.35 k | 25 w | | WW | 5% | |
| R710 | 324-467 | 715 k | 1 w | | Prec | 1% | |
| R711 | 324-604 | 303 k | 1 w | | Prec | 1% | |
| R712 | 302-154 | 150 k | ½ w | | | | |
| R723 | 302-105 | 1 meg | ½ w | | | | |
| R726 | 301-0204-00 | 200 k | ½ w | | | 5% | X520-up |
| R727 | 302-105 | 1 meg | ½ w | | | 5% | X520-up |
| R728 | 302-684 | 680 k | ½ w | | | | 100-519 |
| R728 | 301-0474-00 | 470 k | ½ w | | | 5% | 520-up |
| R729 | 302-224 | 220 k | ½ w | | | | 100-519 |
| R729 | 301-0224-00 | 220 k | ½ w | | | 5% | 520-up |
| R730 | 302-100 | 10 Ω | ½ w | | | | |
| R731 | 306-823 | 82 k | 2 w | | | | |
| R734 | 316-470 | 47 Ω | ¼ w | | | | |
| R737 | 308-192 | 5 k | 20 w | | WW | 5% | |
| R741 | 302-104 | 100 k | ½ w | | | | |
| R743 | 307-103 | 2.7 Ω | ¼ w | | | 5% | |
| R744 | 307-103 | 2.7 Ω | ¼ w | | | 5% | |
| R757 | 302-154 | 150 k | ½ w | | | | |
| R758 | 315-823 | 82 k | ¼ w | | | 5% | |
| R759 | 315-203 | 20 k | ¼ w | | | 5% | |
| R760 | 316-470 | 47 Ω | ¼ w | | | | |
| R761 | 315-472 | 4.7 k | ¼ w | | | 5% | |
| R762 | 301-683 | 68 k | ½ w | | | 5% | |
| R763 | 302-185 | 1.8 meg | ½ w | | | | |
| R764 | 302-105 | 1 meg | ½ w | | | | |
| R765 | 302-474 | 470 k | ½ w | | | | |
| R766 | 316-470 | 47 Ω | ¼ w | | | | |
| R767 | 304-122 | 1.2 k | 1 w | | | | |
| R768 | 308-286 | 8.2 k | 3 w | | WW | 5% | |
| R769 | 316-101 | 100 Ω | ¼ w | | | | |
| R771 | 323-097 | 100 Ω | ½ w | | Prec | 1% | |
| R773 | 323-097 | 100 Ω | ½ w | | Prec | 1% | |
| R774 | 324-097 | 100 Ω | 1 w | | Prec | 1% | |
| R775 | 323-097 | 100 Ω | ½ w | | Prec | 1% | |
| R777 | 307-103 | 2.7 Ω | ¼ w | | | 5% | |
| R778† | 311-407 | 2 x 10 Ω | | Var | WW | TRACE ROTATION | |
| R802 | 306-271 | 270 Ω | 2 w | | | | |
| R803 | 306-563 | 56 k | 2 w | | | | |
| R804 | 316-0104-00 | 100 k | ¼ w | | | | X470-up |
| R806 | Use 302-0823-00 | 82 k | ½ w | | | | |
| R807 | 301-432 | 4.3 k | ½ w | | | 5% | |
| R814 | 302-474 | 470 k | ½ w | | | | |
| R820 | 302-333 | 33 k | ½ w | | | | |

**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R821 | 301-225 | 2.2 meg | ½ w | | | 5% | |
| R822 | 302-333 | 33 k | ½ w | | | | |
| R824 | 305-755 | 7.5 meg | 2 w | | | 5% | |
| R825 | 305-755 | 7.5 meg | 2 w | | | 5% | |
| R826 | 311-450 | 1 meg | | Var | | INTENSITY | 100-519 |
| R826 | 311-0450-01 | 1 meg | | Var | | INTENSITY | 520-up |
| R827 | 302-333 | 33 k | ½ w | | | | |
| R828 | 302-223 | 22 k | ½ w | | | | |
| R830 | 302-335 | 3.3 meg | ½ w | | | | |
| R831 | 306-183 | 18 k | ½ w | | | | |
| R832 | 302-101 | 100 Ω | ½ w | | | | |
| R836 | 316-105 | 1 meg | ¼ w | | | | |
| R840 | 311-034 | 500 k | | Var | | HIGH VOLTAGE | |
| R841 | 303-225 | 2.2 meg | 1 w | | | 5% | |
| R842 | 303-335 | 3.3 meg | 1 w | | | 5% | |
| R843 | 303-275 | 2.7 meg | 1 w | | | 5% | |
| R845 | 303-335 | 3.3 meg | 1 w | | | 5% | |
| R846 | 311-313 | 5 meg | | Var | | FOCUS | 100-519 |
| R846 | 311-0313-01 | 5 meg | | Var | | FOCUS | 520-up |
| R847 | 302-474 | 470 k | ½ w | | | | |
| R853 | 302-103 | 10 k | ½ w | | | | |
| R857 | 302-273 | 27 k | ½ w | | | | |
| R858 | 302-105 | 1 meg | ½ w | | | | |
| R859 | 302-471 | 470 Ω | ½ w | | | | |
| R861 | 311-026 | 100 k | | Var | | GEOMETRY | |
| R862 | 301-823 | 82 k | ½ w | | | 5% | 100-169 |
| R862 | 323-395 | 127 k | ½ w | | Prec | 1% | 170-up |
| R863 | 301-473 | 47 k | ½ w | | | 5% | 100-169 |
| R863 | 323-356 | 49.9 k | ½ w | | Prec | 1% | 170-up |
| R864† | 311-407 | 50 k | | Var | WW | ASTIGMATISM | |
| R931 | 302-154 | 150 k | ½ w | | | | |
| R932 | 301-394 | 390 k | ½ w | | | 5% | |
| R934 | 301-475 | 4.7 meg | ½ w | | | 5% | |
| R935 | 302-103 | 10 k | ½ w | | | | |
| R936 | 302-102 | 1 k | ½ w | | | | |
| R938 | 302-102 | 1 k | ½ w | | | | |
| R939 | 302-221 | 220 Ω | ½ w | | | | |
| R941 | 302-221 | 220 Ω | ½ w | | | | |
| R943 | 311-141 | 2 k | | Var | WW | CAL AMPL | |
| R944 | 302-100 | 10 Ω | ½ w | | | | |
| R945 | 308-268 | 22 k | 5 w | | WW | 1% | |
| R948 | 315-0682-00 | 6.8 k | ¼ w | | | 5% | X200-up |
| R949 | 302-274 | 270 k | ½ w | | | | |
| R950 | 323-0289-00 | 10 k | ½ w | | Prec | 1% | 100-199 |
| R950 | 323-0709-01 | 10.048 k | ½ w | | Prec | ½% | 200-up |
| R951 | 323-0635-00 | 6.66 k | ½ w | | Prec | 1% | 100-199 |
| R951 | 323-0708-01 | 6.628 k | ½ w | | Prec | ½% | 200-up |

†R778 and R864 furnished as a unit.

**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R952 | 323-0634-00 | 1.789 k | ½ w | | Prec | 1% | 100-199 |
| R952 | 323-0707-01 | 1.782 k | ½ w | | Prec | ½% | 200-up |
| R953 | 323-0633-00 | 801 Ω | ½ w | | Prec | 1% | 100-199 |
| R953 | 323-0706-01 | 800 Ω | ½ w | | Prec | ½% | 200-up |
| R954 | 323-0632-00 | 452 Ω | ½ w | | Prec | 1% | 100-199 |
| R954 | 323-0705-01 | 452 Ω | ½ w | | Prec | ½% | 200-up |
| R955 | 323-0631-00 | 146.1 Ω | ½ w | | Prec | 1% | 100-199 |
| R955 | 323-0704-01 | 146 Ω | ½ w | | Prec | ½% | 200-up |
| R956 | 323-0630-00 | 72.4 Ω | ½ w | | Prec | 1% | 100-199 |
| R956 | 323-0703-01 | 72.4 Ω | ½ w | | Prec | ½% | 200-up |
| R957 | 323-0629-00 | 43.1 Ω | ½ w | | Prec | 1% | 100-199 |
| R957 | 323-0702-01 | 43.1 Ω | ½ w | | Prec | ½% | 200-up |
| R958 | 323-0628-00 | 28.6 Ω | ½ w | | Prec | 1% | 100-199 |
| R958 | 323-0701-01 | 28.6 Ω | ½ w | | Prec | ½% | 200-up |
| R960 | 323-636 | 50 k | ½ w | | Prec | 1% | |
| R962 | 323-0627-00 | 21.4 Ω | ½ w | | Prec | 1% | 100-199 |
| R962 | 323-0700-01 | 21.4 Ω | ½ w | | Prec | ½% | 200-up |
| R964 | 323-638 | 50 k | ½ w | | Prec | ¼% | |
| R965 | 323-637 | 50 Ω | ½ w | | Prec | ¼% | |
| R969 | 308-242 | 0.25 Ω | 5 w | | WW | 5% | |
| R1000 | 316-820 | 82 Ω | ¼ w | | | | |
| R1001 | 315-220 | 22 Ω | ¼ w | | | 5% | |
| R1002 | 301-101 | 100 Ω | ½ w | | | 5% | |
| R1003 | 305-682 | 6.8 k | 2 w | | | 5% | |
| R1004 | 311-086 | 2.5 k | | Var | | VERT DC BAL | 100-499 |
| R1004 | 311-0629-00 | 3 k | | Var | | VERT DC BAL | 500-up |
| R1011 | 315-220 | 22 Ω | ¼ w | | | 5% | |
| R1013 | 305-682 | 6.8 k | 2 w | | | 5% | |
| R1014 | 301-131 | 130 Ω | ½ w | | | 5% | |
| R1015 | 315-131 | 130 Ω | ¼ w | | | 5% | |
| R1016 | 315-300 | 30 Ω | ¼ w | | | 5% | |
| R1017 | 311-258 | 100 Ω | | Var | | VERT GAIN | 100-469 |
| R1017 | 311-0097-00 | 200 Ω | | Var | | VERT GAIN | 470-up |
| R1018 | 305-273 | 27 k | 2 w | | | 5% | |
| R1019 | 308-002 | 1.5 k | 5 w | | WW | 5% | |
| R1020 | 316-331 | 330 Ω | ¼ w | | | | X170-up |
| R1024 | 301-131 | 130 Ω | ½ w | | | 1% | |
| R1025 | 315-131 | 130 Ω | ¼ w | | | 5% | |
| R1026 | 315-300 | 30 Ω | ¼ w | | | 5% | |
| R1027 | 315-121 | 120 Ω | ¼ w | | | 5% | 100-169 |
| R1027 | 315-471 | 470 Ω | ¼ w | | | 5% | 170-up |
| R1031 | 315-512 | 5.1 k | ¼ w | | | 5% | |
| R1032 | 322-092 | 88.7 Ω | ¼ w | | Prec | 1% | |
| R1034 | 315-100 | 10 Ω | ¼ w | | | 5% | |
| R1038 | 301-821 | 820 Ω | ½ w | | | 5% | |

**Resistors** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | | Description | | | | S/N Range |
|---|---|---|---|---|---|---|---|
| R1041 | 315-512 | 5.1 k | 1/4 w | | | 5% | |
| R1042 | 322-092 | 88.7 Ω | 1/4 w | | Prec | 1% | |
| R1048 | 301-821 | 820 Ω | 1/2 w | | | 5% | |
| R1051 | 321-117 | 162 Ω | 1/8 w | | Prec | 1% | |
| R1061 | 321-117 | 162 Ω | 1/8 w | | Prec | 1% | |
| R1069 | 315-361 | 360 Ω | 1/4 w | | | 5% | |
| R1071 | 315-360 | 36 Ω | 1/4 w | | | 5% | |
| R1072 | 323-105 | 121 Ω | 1/2 w | | Prec | 1% | |
| R1073 | 301-331 | 330 Ω | 1/2 w | | | 5% | |
| R1074 | 321-073 | 56.2 Ω | 1/8 w | | Prec | 1% | |
| R1076 | 311-442 | 250 Ω | | Var | | | |
| R1077 | 315-163 | 16 k | 1/4 w | | | 5% | |
| R1082 | 323-105 | 121 Ω | 1/2 w | | Prec | 1% | |
| R1083 | 301-331 | 330 Ω | 1/2 w | | | 5% | |
| R1084 | 321-073 | 56.2 Ω | 1/8 w | | Prec | 1% | |
| R1087 | 304-122 | 1.2 k | 1 w | | | | |
| R1088 | 305-681 | 680 Ω | 2 w | | | 5% | |
| R1089 | 308-296 | 1.2 k | 5 w | | WW | 5% | |
| R1104 | 301-270 | 27 Ω | 1/2 w | | | 5% | |
| R1105 | 323-102 | 113 Ω | 1/2 w | | Prec | 1% | |
| R1106 | 311-442 | 250 Ω | | Var | | | |
| R1108 | *310-603 | 600 Ω/300 Ω | 3 w | | WW | 2% | |
| R1109 | 305-0243-00 | 24 k | 2 w | | | 5% | X170-up |
| R1113 | 315-100 | 10 Ω | 1/4 w | | | 5% | |
| R1114 | *310-602 | 1 k | 8 w | | WW | 1% | |
| R1118 | 308-232 | 320 Ω | 5 w | | WW | 5% | |
| R1124 | 301-270 | 27 Ω | 1/2 w | | | 5% | |
| R1126 | 321-204 | 1.3 k | 1/8 w | | Prec | 1% | |
| R1129 | 308-283 | 800 Ω | 10 w | | WW | 5% | |
| R1132 | 315-100 | 10 Ω | 1/4 w | | | 5% | |
| R1134 | *310-602 | 1 k | 8 w | | WW | 1% | |
| R1141 | 322-092 | 88.7 Ω | 1/4 w | | Prec | 1% | |
| R1142 | 315-331 | 330 Ω | 1/4 w | | | 5% | |
| R1144 | 301-681 | 680 Ω | 1/2 w | | | 5% | |
| R1151 | 322-092 | 88.7 Ω | 1/4 w | | Prec | 1% | |
| R1152 | 315-331 | 330 Ω | 1/4 w | | | 5% | |
| R1153 | 315-100 | 10 Ω | 1/4 w | | | 5% | |
| R1154 | 301-681 | 680 Ω | 1/2 w | | | 5% | |
| R1156 | 315-820 | 82 Ω | 1/4 w | | | 5% | |
| R1157 | 315-361 | 360 Ω | 1/4 w | | | 5% | |
| R1161 | 315-221 | 220 Ω | 1/4 w | | | 5% | |
| R1163 | 308-258 | 6 k | 3 w | | WW | 5% | |
| R1165 | 315-820 | 82 Ω | 1/4 w | | | 5% | |
| R1166 | 302-221 | 220 Ω | 1/2 w | | | | |
| R1169 | 302-105 | 1 meg | 1/2 w | | | | |
| R1173 | 308-258 | 6 k | 3 w | | WW | 5% | |
| R1175 | 315-820 | 82 Ω | 1/4 w | | | 5% | |
| R1181 | 315-105 | 1 meg | 1/4 w | | | 5% | |
| R1184 | 301-334 | 330 k | 1/2 w | | | 5% | |
| R1187 | 301-334 | 330 k | 1/2 w | | | 5% | |
| R1191 | 315-105 | 1 meg | 1/4 w | | | 5% | |
| R1194 | 301-334 | 330 k | 1/2 w | | | 5% | |

## Switches

| Ckt. No. | Tektronix Part No. Unwired | Wired | Description | | S/N Range |
|---|---|---|---|---|---|
| SW1 | 260-495 | *262-598 | Lever | SOURCE | |
| SW5 | 260-494 | | Lever | COUPLING | |
| SW10 | 260-542 | | Lever | SLOPE | |
| SW75 | 260-493 | | Lever | MODE | |
| SW15† | 311-426 | | | PULL FOR X10 RANGE INCREASE | |
| SW90 | 260-531 | *262-596 | Rotary | B TIME/CM OR DELAY TIME | 100-479 |
| SW90 | 260-0531-00 | *262-0596-01 | Rotary | B TIME/CM OR DELAY TIME | 480-up |
| SW90Z†† | 311-391 | | | | |
| SW201 | 260-495 | Use *262-692 | Lever | SOURCE | |
| SW205 | 260-494 | | Lever | COUPLING | |
| SW210 | 260-542 | | Lever | SLOPE | |
| SW375 | 260-493 | | Lever | MODE | |
| SW215††† | 311-426 | | | PULL FOR X10 RANGE INCREASE | |
| SW290 | 260-530 | *262-595 | Rotary | A TIME/CM | 100-479 |
| SW290 | 260-0530-00 | *262-0595-01 | Rotary | A TIME/CM | 480-up |
| SW290Z†††† | 311-391 | | | | |
| SW369 | 260-496 | *262-602 | Lever | SINGLE SWEEP | |
| SW135 | 260-516 | | Push | RESET | |
| SW530 | 260-533 | *262-604 | Rotary | HORIZONTAL DISPLAY Rear | |
| SW557 | 260-532 | *262-603 | Rotary | HORIZONTAL DISPLAY Front | |
| SW601 | 260-199 | | Toggle | POWER ON | |
| SW673 | 260-516 | | Push | | |
| SW858 | 260-209 | | Toggle | CRT CATHODE SELECTOR | |
| SW950 | 260-536 | Use *262-0731-00 | Rotary | AMPLITUDE CALIBRATOR | |
| SW1000 | 260-601 | | Slide | COMPENSATION | |
| TK601 | 260-336 | | Thermal Cutout 150°F ±5°F | | |

## Transformers

| | | | |
|---|---|---|---|
| T52 | Use *120-0323-01 | Toroid 2T - 8T Bifilar | 100-499 |
| T52 | *120-0500-00 | Toroid 2T - 12T Bifilar | 500-up |
| T252 | Use *120-0323-01 | Toroid 2T - 8T Bifilar | 100-499 |
| T252 | *120-0500-00 | Toroid 2T - 12T Bifilar | 500-up |
| T601 | *120-307 | L.V. Power | |
| T801 | *120-308 | H.V. Power | |
| T1030 | *120-341 | Toroid 3T Bifilar | |
| T1104 | 276-541 | Core, Ferrite | |

## Electron Tubes

| | | | |
|---|---|---|---|
| V24 | 154-187 | 6DJ8 | 100-489 |
| V24 | *157-0122-00 | 6DJ8, checked | 490-578 |
| V24 | *157-0125-00 | 6DJ8, checked | 579-up |
| V91 | Use 154-0040-05 | 8426 | |
| V93 | 154-187 | 6DJ8 | |
| V145 | 154-187 | 6DJ8 | |

†Furnished as a unit with R15.
††Furnished as a unit with R90Z.
†††Furnished as a unit with R215.
††††Furnished as a unit with R290Z.

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**Electron Tubes** *(Cont'd)*

| Ckt. No. | Tektronix Part No. | Description | S/N Range |
|---|---|---|---|
| V193 | 154-187 | 6DJ8 | |
| V224 | 154-187 | 6DJ8 | 100-489 |
| V224 | *157-0122-00 | 6DJ8, checked | 490-578 |
| V224 | *157-0125-00 | 6DJ8, checked | 579-up |
| V291 | 154-022 | 6AU6 | |
| V293 | 154-187 | 6DJ8 | |
| V345 | 154-187 | 6DJ8 | |
| V393 | 154-187 | 6DJ8 | |
| V404 | 154-187 | 6DJ8 | |
| V514 | 154-187 | 6DJ8 | |
| V574 | 154-187 | 6DJ8 | |
| V584 | 154-187 | 6DJ8 | |
| V589 | 154-146 | 6197 | |
| V609 | 154-291 | OG3 | |
| V624 | 154-043 | 12AX7 | |
| V634 | 154-022 | 6AU6 | |
| V637 | 154-202 | 6CW5 | |
| V647 | 154-202 | 6CW5 | |
| V664 | 154-414 | 6BY8 | |
| V677 | 154-056 | 6080 | |
| V684 | 154-043 | 12AX7 | |
| V694 | 154-022 | 6AU6 | |
| V707 | 154-056 | 6080 | |
| V724 | 154-022 | 6AU6 | |
| V737 | 154-202 | 6CW5 | |
| V764 | 154-187 | 6DJ8 | |
| V800 | 154-021 | 6AU5 | |
| V814 | 154-041 | 12AU7 | |
| V822 | 154-051 | 5642 | |
| V832 | 154-051 | 5642 | |
| V842 | 154-051 | 5642 | |
| V852 | 154-051 | 5642 | |
| V859† | Use *154-0478-00 | T5470-31-2 Crt Standard Phosphor | 100-169 |
| V859 | *154-0478-00 | T5470-31-2 Crt Standard Phosphor | 170-up |
| V862 | 154-051 | 5642 | |
| V935 | 154-041 | 12AU7 | |
| V945 | 154-022 | 6AU6 | |
| V1003 | 154-039 | 12AT7 | 100-499 |
| V1003 | *157-0118-00 | 12AT7, aged | 500-up |
| V1184 | 154-043 | 12AX7 | |

† S/N 100-169 add *050-0246-00 kit.

**IMPORTANT:**

All circuit voltages were obtained with a 20,000 Ω/Volt VOM.

All readings are in volts. The voltages were measured with respect to ground unless otherwise indicated by the use of arrows to point out voltage drop.

Waveforms were obtained using a Type 530-Series Oscilloscope with a Type L Plug-In Unit and 10X attenuator probe. An equivalent oscilloscope having a vertical passband of dc to 10 mc or better and equal sensitivity can be used as a test oscilloscope.

Waveform dc levels with respect to ground are indicated at the right side of waveform; measured when test oscilloscope AC-DC switch was set to DC.

Waveforms were photographed with test oscilloscope AC-DC switch set to AC; vertical deflection factor and Time/Cm switch set to those settings indicated adjacent to waveforms.

In most cases +Ext. AC triggering on the Type 546 1-kc AMPLITUDE CALIBRATOR signal was used. Exception: +Int. triggering mode is also used; this mode, if used, is indicated above the waveform.

NOTE

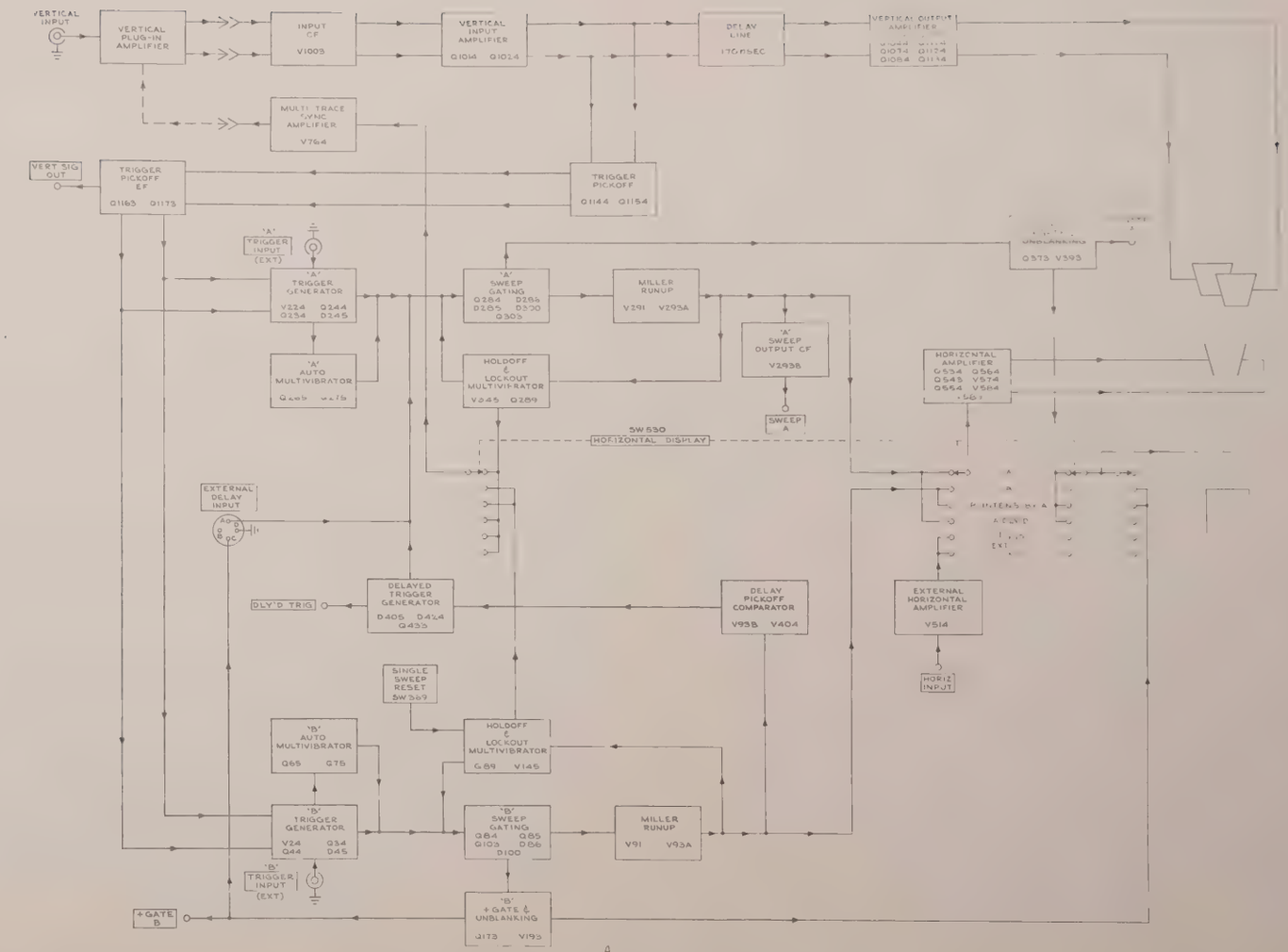
Number of cycles displayed by waveform when calibrator signal was used as a trigger source depends mostly on the signal repetition rate. Though +Ext. triggering was used, a time difference of 1 msec can occur between waveforms because the test oscilloscope can trigger on a different cycle than the Type 546 and vice versa.

Voltage and waveform measurements are not absolute. They may vary between instruments due to normal manufacturing tolerances, and transistor and vacuum tube characteristics.

The plug-in unit used in the Type 546 Oscilloscope during the voltage and waveform measurements is a Type TU-7 Test Unit. Its front-panel control settings and other conditions are as follows:

| | |
|---|---|
| Input Signal ..... | None |
| Position ..... | Centered (Exception: See Vertical Amplifier schematic diagram) |
| Test Function ..... | Low Load |

Any letter-series or 1-series plug-in unit or the TU-2 can be used in place of the Type TU-7 when troubleshooting the Type 546.


VERTICAL INPUT
VERTICAL PLUG-IN AMPLIFIER
INPUT CF V1003
VERTICAL INPUT AMPLIFIER Q1014 Q1024
DELAY LINE 1TO/USEC
VERTICAL OUTPUT AMPLIFIER
MULTI TRACE SYNC AMPLIFIER V764
VERT SIG OUT
TRIGGER PICKOFF EF Q1163 Q1173
TRIGGER PICKOFF Q1144 Q1154
'A' TRIGGER INPUT (EXT)
'A' TRIGGER GENERATOR V224 Q244 Q254 D245
'A' SWEEP GATING Q284 D286 Q285 D230 Q303
MILLER RUNUP V291 V293A
'A' SWEEP OUTPUT CF V293B
'A' AUTO MULTIVIBRATOR Q265 Q275
HOLDOFF & LOCKOUT MULTIVIBRATOR V245 Q289
SWEEP A
SW530 HORIZONTAL DISPLAY
HORIZONTAL AMPLIFIER Q554 Q564 Q543 V574 Q564 V584
EXTERNAL DELAY INPUT
DLY'D TRIG
DELAYED TRIGGER GENERATOR D405 D424 Q435
DELAY PICKOFF COMPARATOR V93B V404
EXTERNAL HORIZONTAL AMPLIFIER V514
HORIZ INPUT
SINGLE SWEEP RESET SW569
'B' AUTO MULTIVIBRATOR Q65 Q75
HOLDOFF & LOCKOUT MULTIVIBRATOR Q89 V145
'B' TRIGGER GENERATOR V24 Q34 Q44 D45
'B' SWEEP GATING Q84 Q85 Q103 D86 D100
MILLER RUNUP V91 V93A
'B' TRIGGER INPUT (EXT)
+GATE B
'B' +GATE & UNBLANKING Q173 V193

TYPE RM546 OSCILLOSCOPE

A

BLOCK DIAGRAM

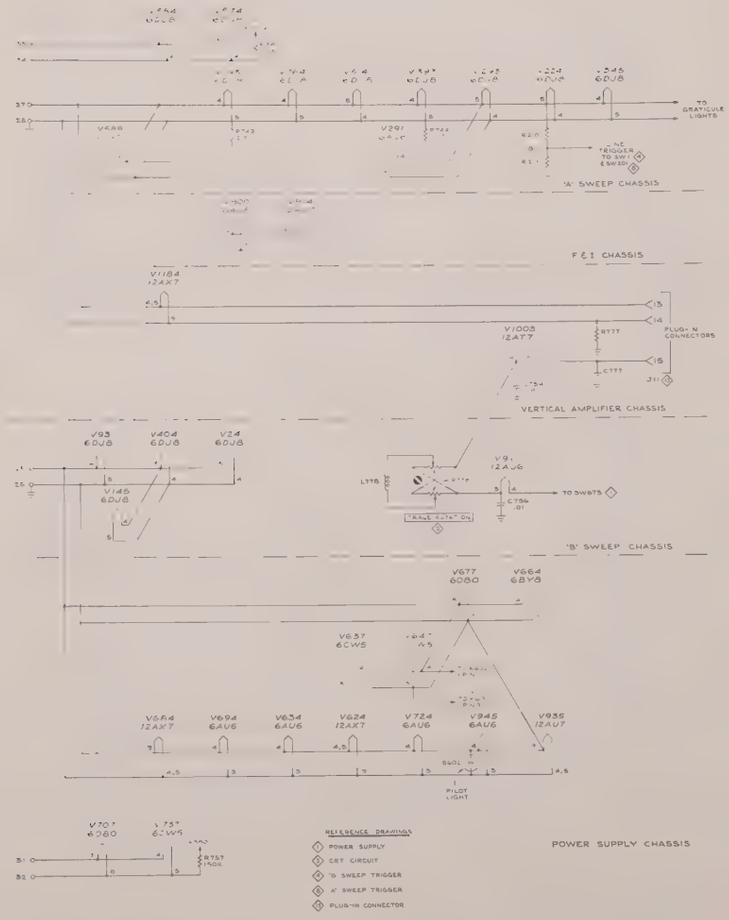
DON 2-64

## POWER SUPPLY

VOLTAGE READINGS WERE OBTAINED under the following conditions:

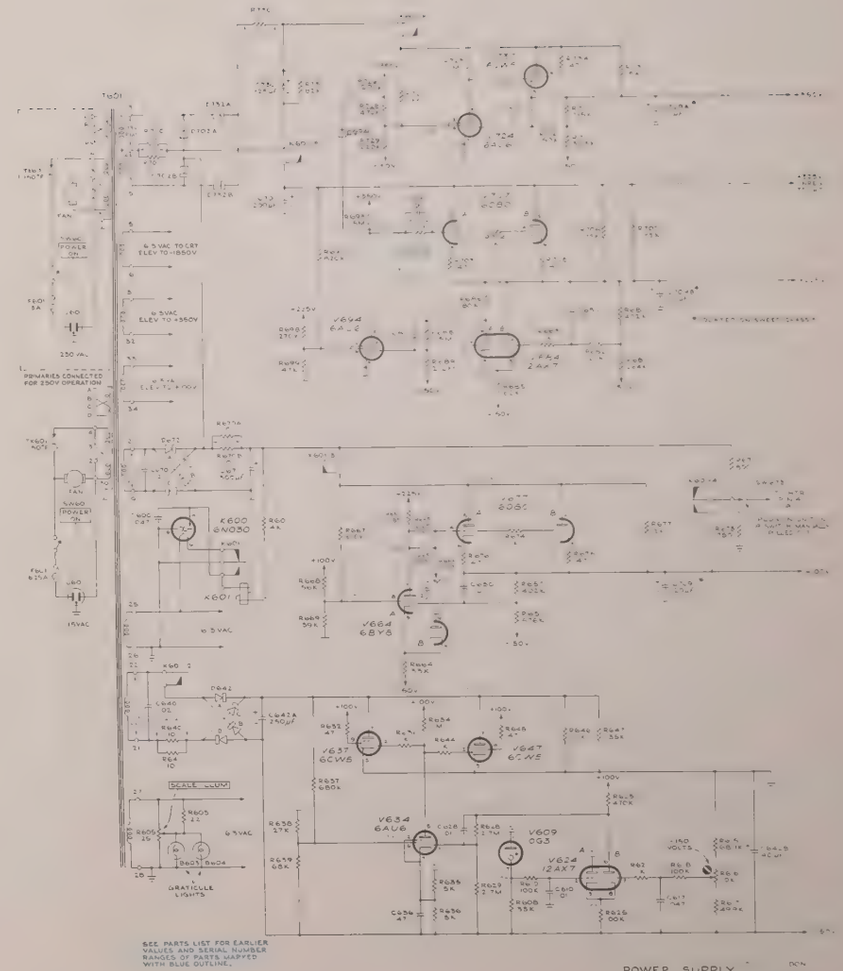
| | |
|---|---|
| LINE VOLTAGE | 115 VAC (or Design Center) |
| INPUT SIGNAL | None |
| 'A' AND 'B' TRIGGER INPUT Signal | None |
| 'A' AND 'B' TRIGGERING LEVEL | ccw |
| 'A' AND 'B' TRIGGERING MODE | TRIG |
| 'A' AND 'B' TRIGGERING SOURCE | EXT |
| AMPLITUDE CALIBRATOR | OFF |
| POWER | ON |

Also see IMPORTANT note on Block Diagram.




TYPE RM546 OSCILLOSCOPE

HEATER WIRING DIAGRAM




POWER SUPPLY

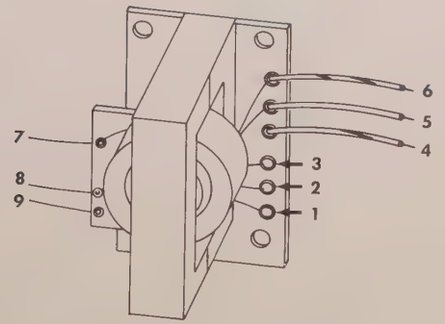
## CRT CIRCUIT

WAVEFORM AND DYNAMIC VOLTAGE READINGS were obtained under the following conditions:

| | |
|---|---|
| INTENSITY | CCW |
| POWER | ON |

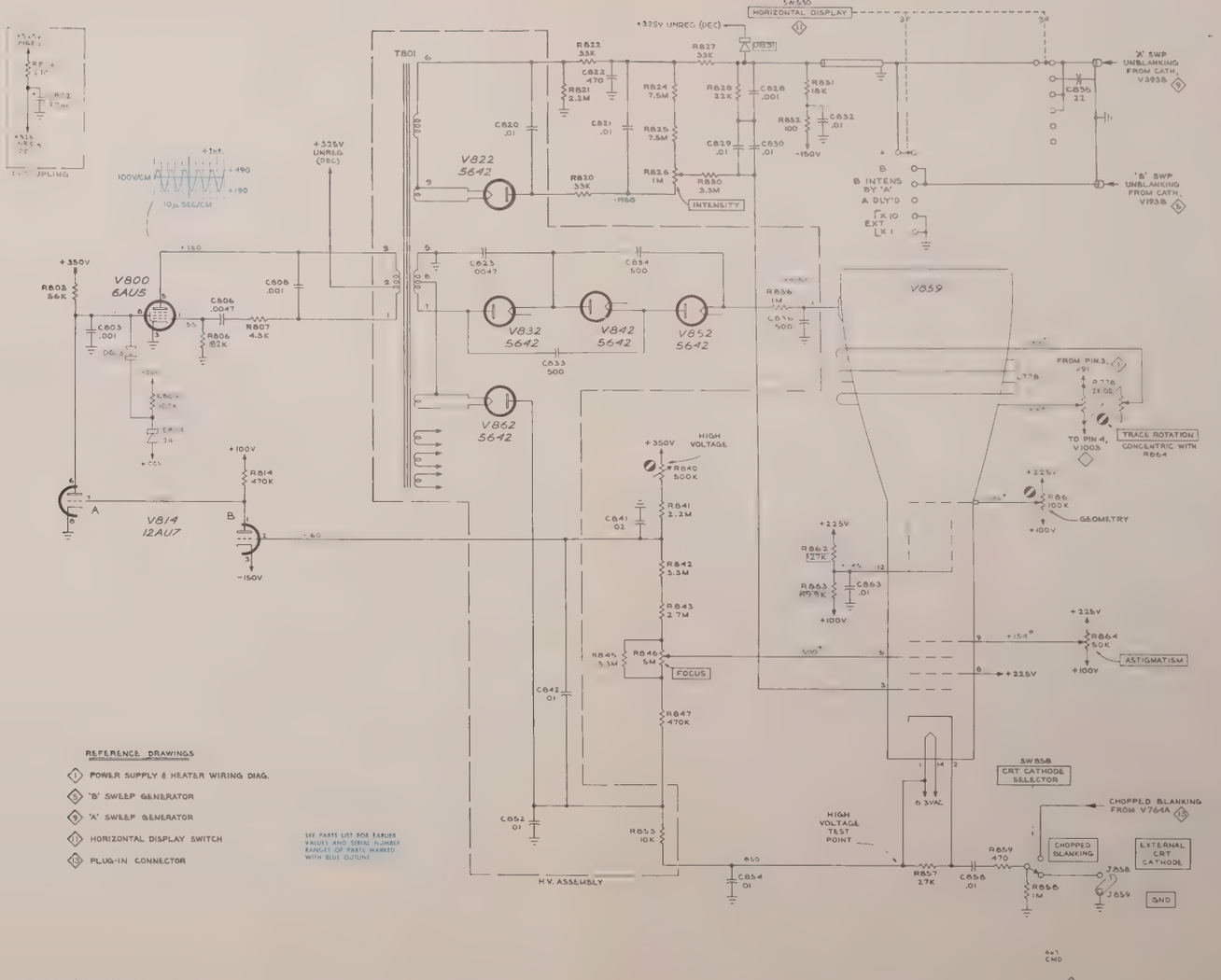
* Voltage reading obtained with associated control set for normal operation. Voltage is dependent on position of the control.

Also see IMPORTANT note on Block Diagram.




**T801 TRANSFORMER DETAILS**

**T801 TRANSFORMER DETAILS**




CRT CIRCUIT 2

## VERTICAL AMPLIFIER

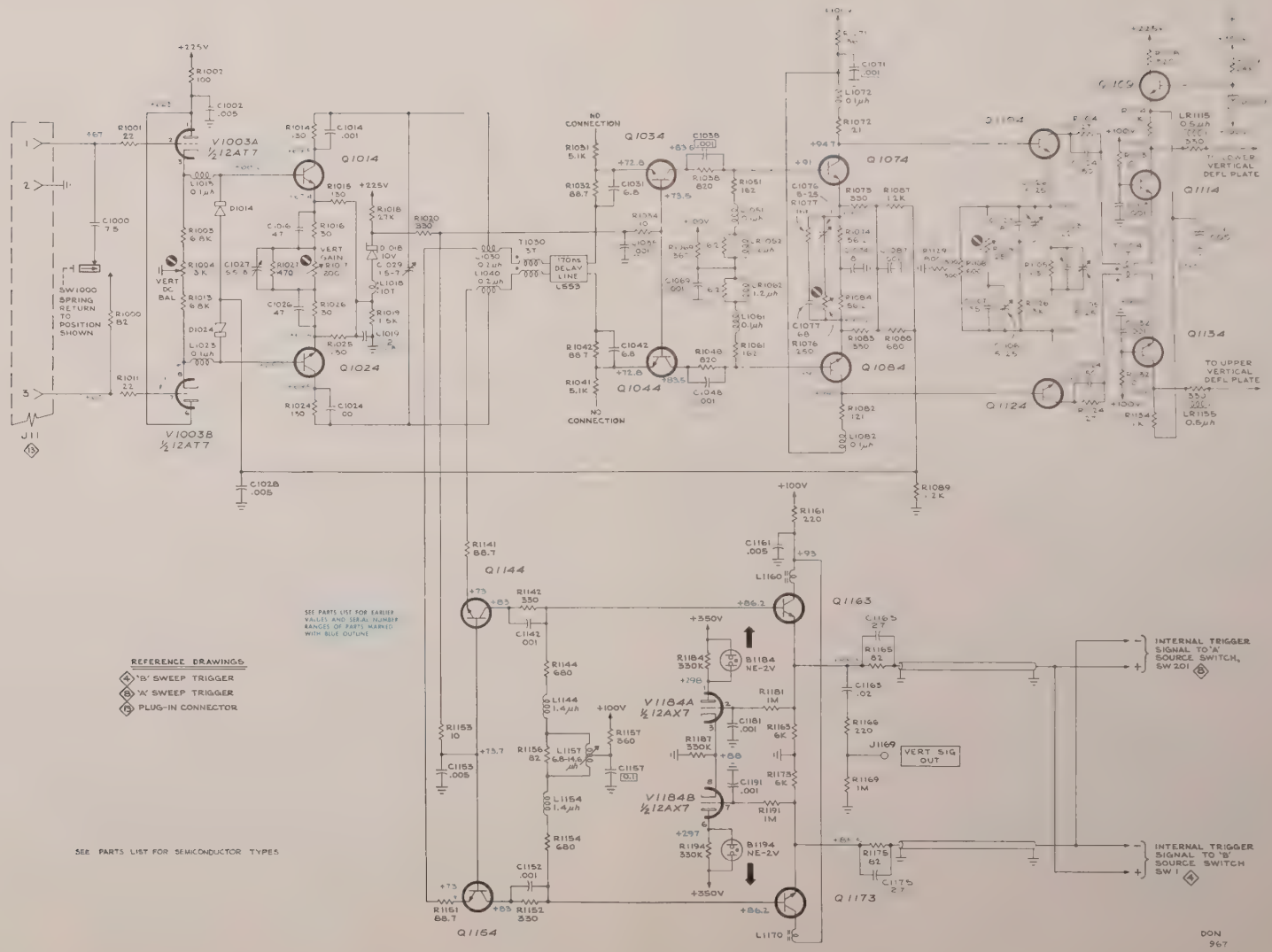
QUIESCENT VOLTAGE READINGS were obtained under the following conditions:

Type 546 Oscilloscope:
POWER ..... ON

Type TU-7:
INPUT SIGNAL ..... None
VERTICAL POSITION ..... Centered*
TEST FUNCTION ..... COMMON MODE

*If a letter-series or '1'-series plug-in unit is used, adjust the plug-in unit Vertical Position control to obtain zero volts reading between pins 1 and 3 of the interconnecting plug.

Also see IMPORTANT note on Block Diagram.




TYPE RM546 OSCILLOSCOPE



VERTICAL AMPLIFIER 13

## VERTICAL AMPLIFIER

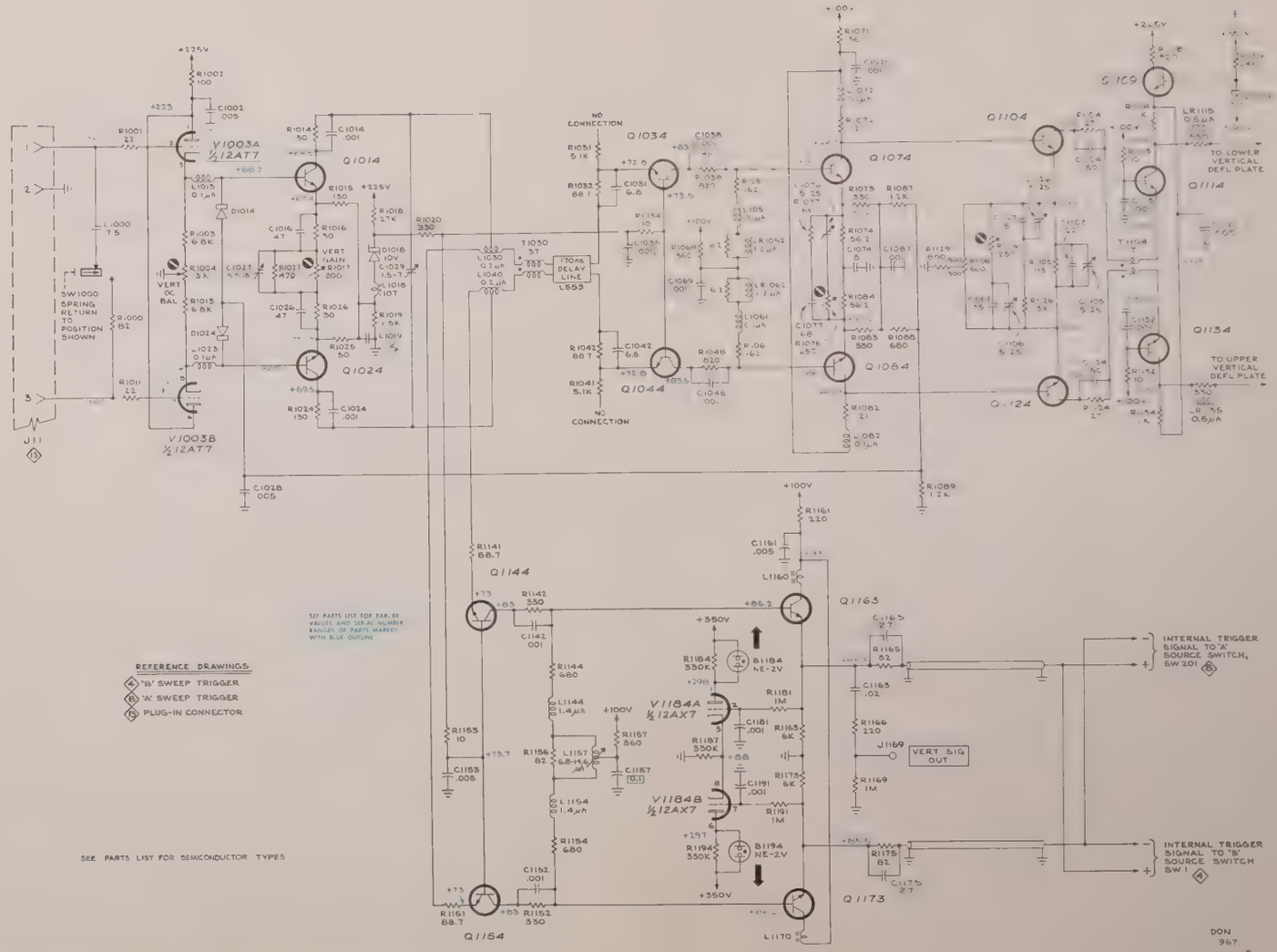
QUIESCENT VOLTAGE READINGS were obtained under the following conditions:

Type 546 Oscilloscope:
POWER ..... ON

Type TU-7:
INPUT SIGNAL ..... None
VERTICAL POSITION ..... Centered*
TEST FUNCTION ..... COMMON MODE

*If a letter-series or '1'-series plug-in unit is used, adjust the plug-in unit Vertical Position control to obtain zero volts reading between pins 1 and 3 of the interconnecting plug.

Also see IMPORTANT note on Block Diagram.




TYPE RM546 OSCILLOSCOPE

I

DON 967

VERTICAL AMPLIFIER 3

## 'B' SWEEP TRIGGER

WAVEFORMS AND VOLTAGE READINGS were obtained under the following conditions:

TIME BASE A —
- TRIGGER INPUT Signal ..... None
- TRIGGERING:
  - MODE ..... TRIG
  - SOURCE ..... EXT

MAIN TIME BASE (B) —
- TRIGGERING:
  - MODE ..... TRIG
  - SLOPE ..... +
  - COUPLING ..... AC
  - SOURCE ..... EXT

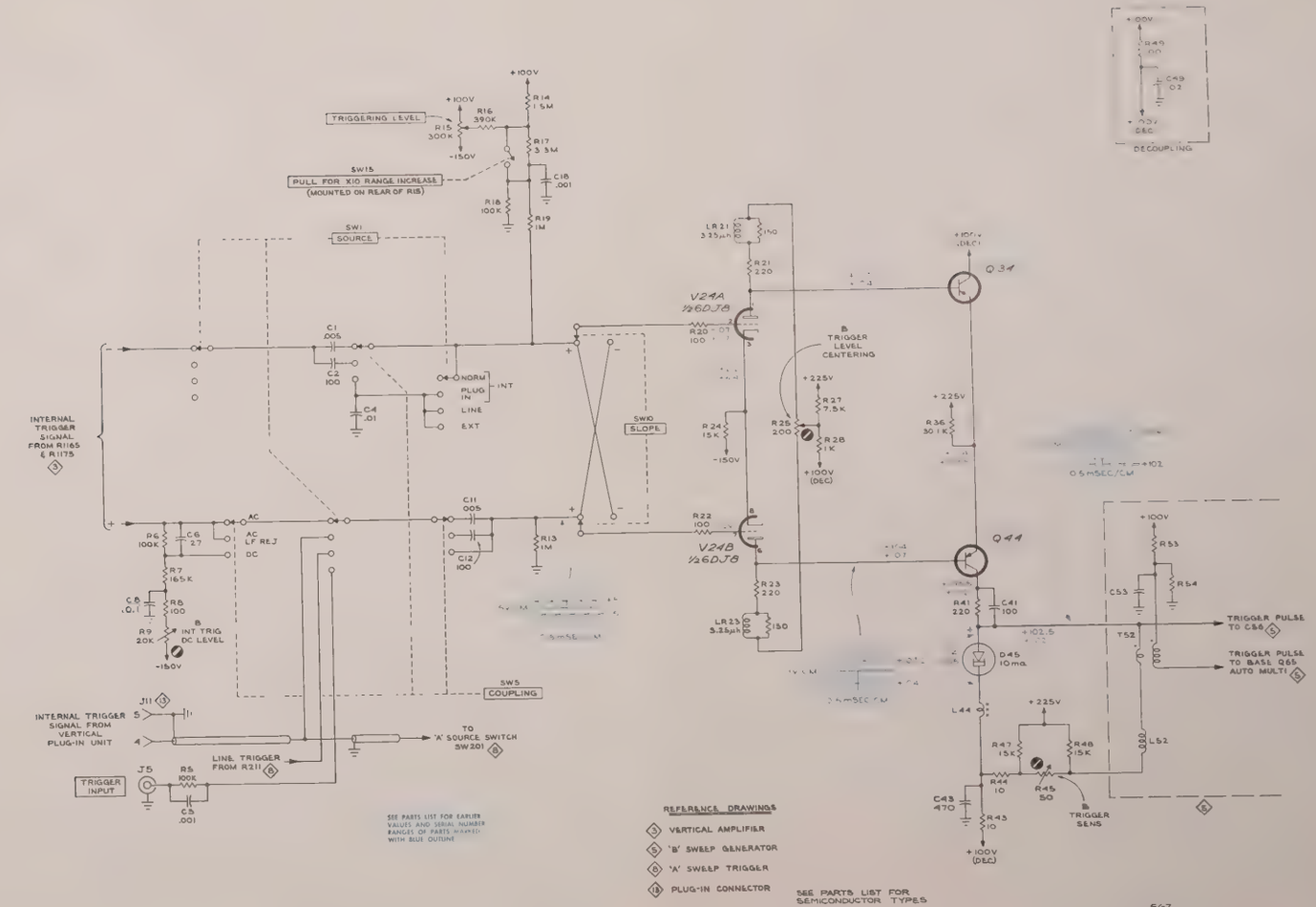
HORIZONTAL DISPLAY ..... B

POWER ..... ON

WAVEFORM Conditions —
- 'B' TRIGGER INPUT Signal ..... 10 Volts P-P Calibrator
- 'B' TRIGGERING LEVEL ..... +45°; knob pushed in
- 'B' TIME/CM ..... .1 mSEC
- AMPLITUDE CALIBRATOR ..... 10 Volts

QUIESCENT VOLTAGE Conditions —
- 'B' TRIGGER INPUT Signal ..... None
- 'B' TRIGGERING LEVEL with knob pushed in:
  - Upper Voltage Readings ..... ccw
  - Lower Voltage Readings ..... cw

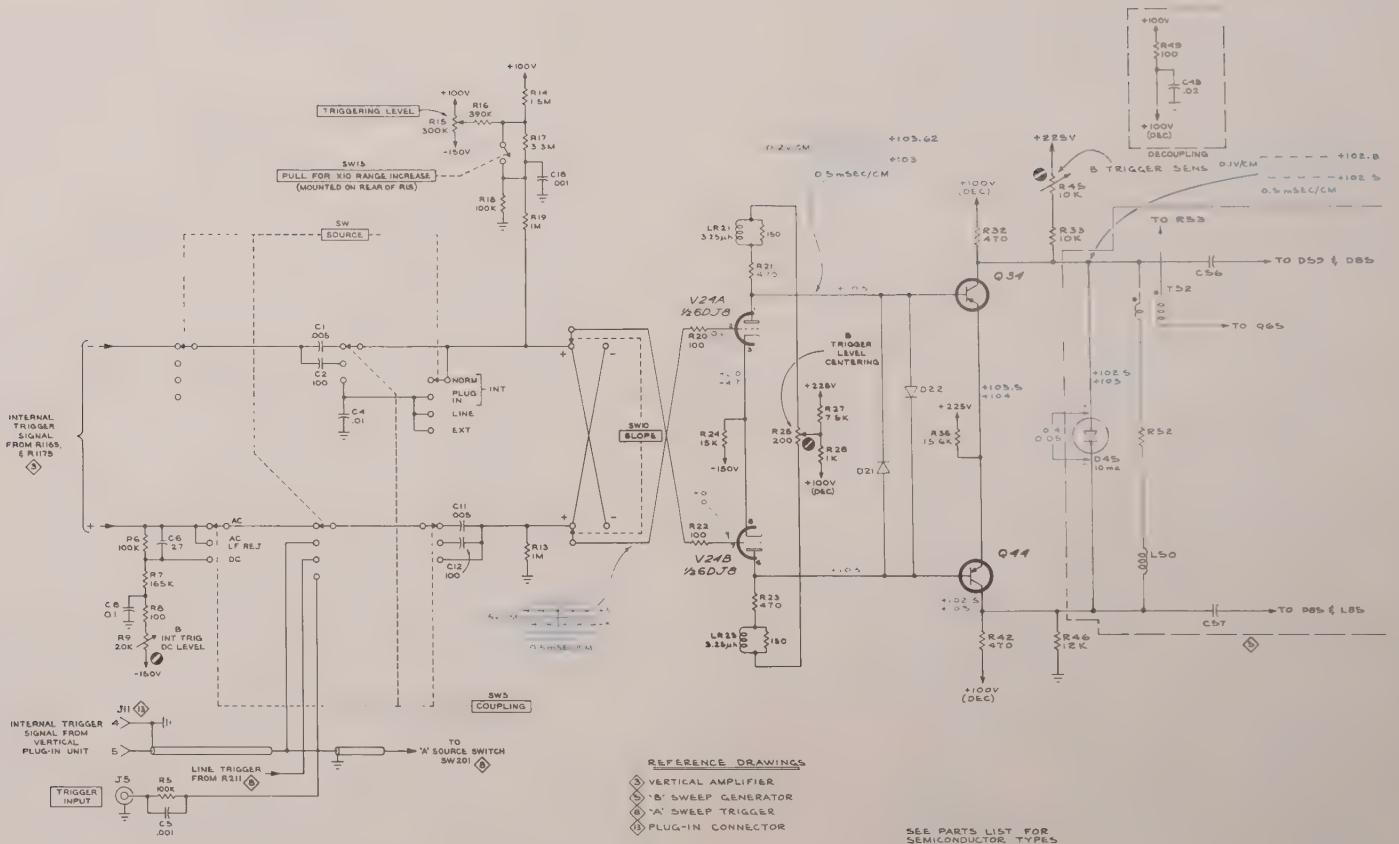
Also see IMPORTANT note on Block Diagram.




TYPE RM546 OSCILLOSCOPE

'B' SWEEP TRIGGER 4
(S/N 100 - 499)

567 CMD




TPYE RM546 OSCILLOSCOPE

A

CHD 367

'B' SWEEP TRIGGER 4
(S/N 500 -UP)

## 'B' SWEEP GENERATOR

WAVEFORMS AND VOLTAGE READINGS were obtained under the following conditions:

TIME BASE A —
- TRIGGER INPUT Signal ..... None
- TRIGGERING:
  - MODE ..... TRIG
  - SOURCE ..... EXT

HORIZONTAL DISPLAY ..... B
- SINGLE SWEEP Switch ..... NORMAL

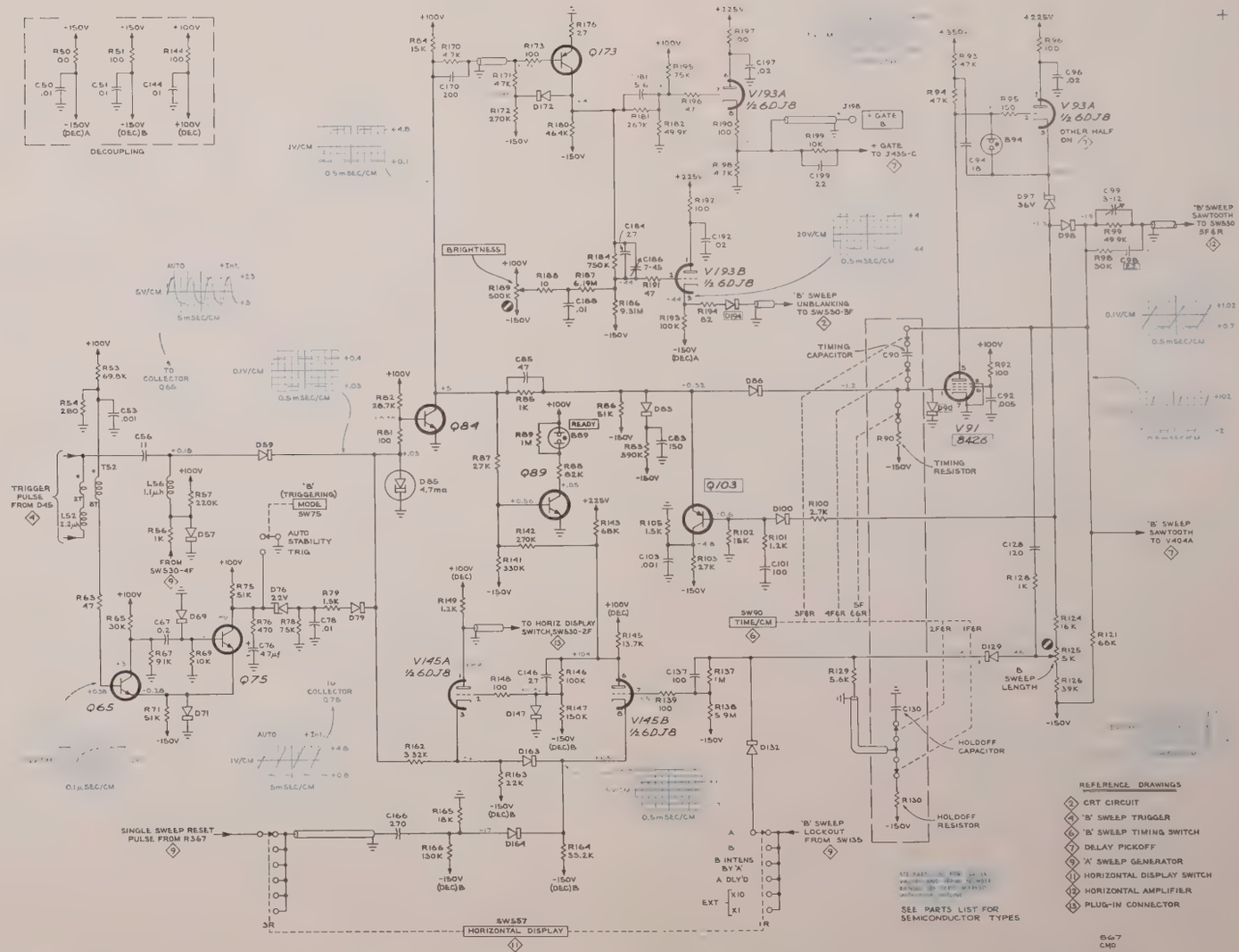
MAIN TIME BASE (B)
- TRIGGERING LEVEL ..... +45°; pushed in
- TRIGGERING:
  - SLOPE ..... +
  - COUPLING ..... AC
  - SOURCE ..... EXT
- BRIGHTNESS ..... cw
- TIME/CM ..... .1 mSEC
- VARIABLE (TIME/CM) ..... CALIBRATED

POWER ..... ON

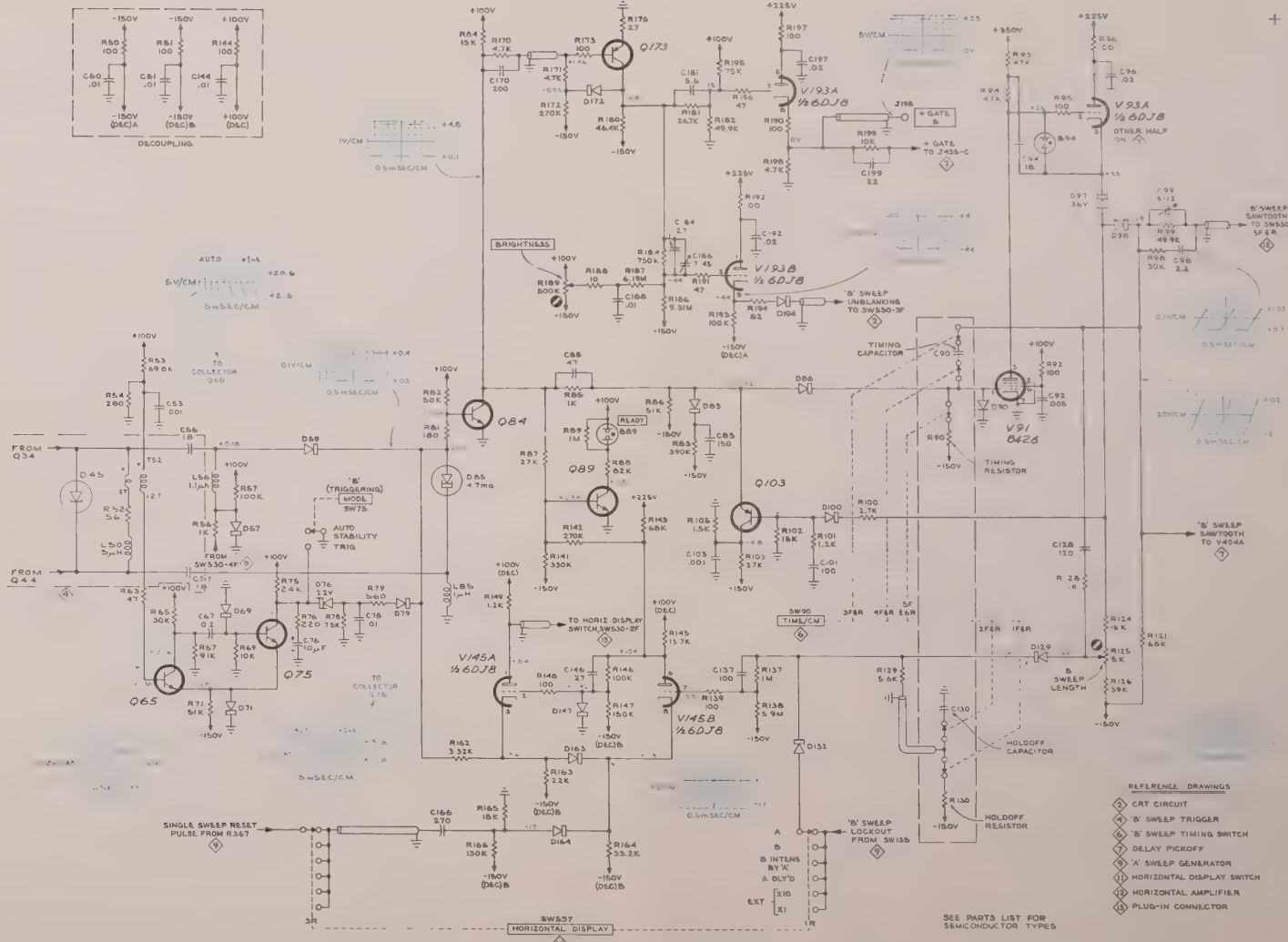
WAVEFORM CONDITIONS —
- 'B' TRIGGER INPUT SIGNAL ..... 10 Volts P-P Calibrator
- 'B' TRIGGERING MODE ..... TRIG (AUTO for waveforms at collectors of Q65 and Q75).
- AMPLITUDE CALIBRATOR ..... 10 Volts

QUIESCENT VOLTAGE CONDITIONS —
- 'B' TRIGGER INPUT SIGNAL ..... None
- 'B' TRIGGERING MODE ..... TRIG

Also see IMPORTANT note on Block Diagram.



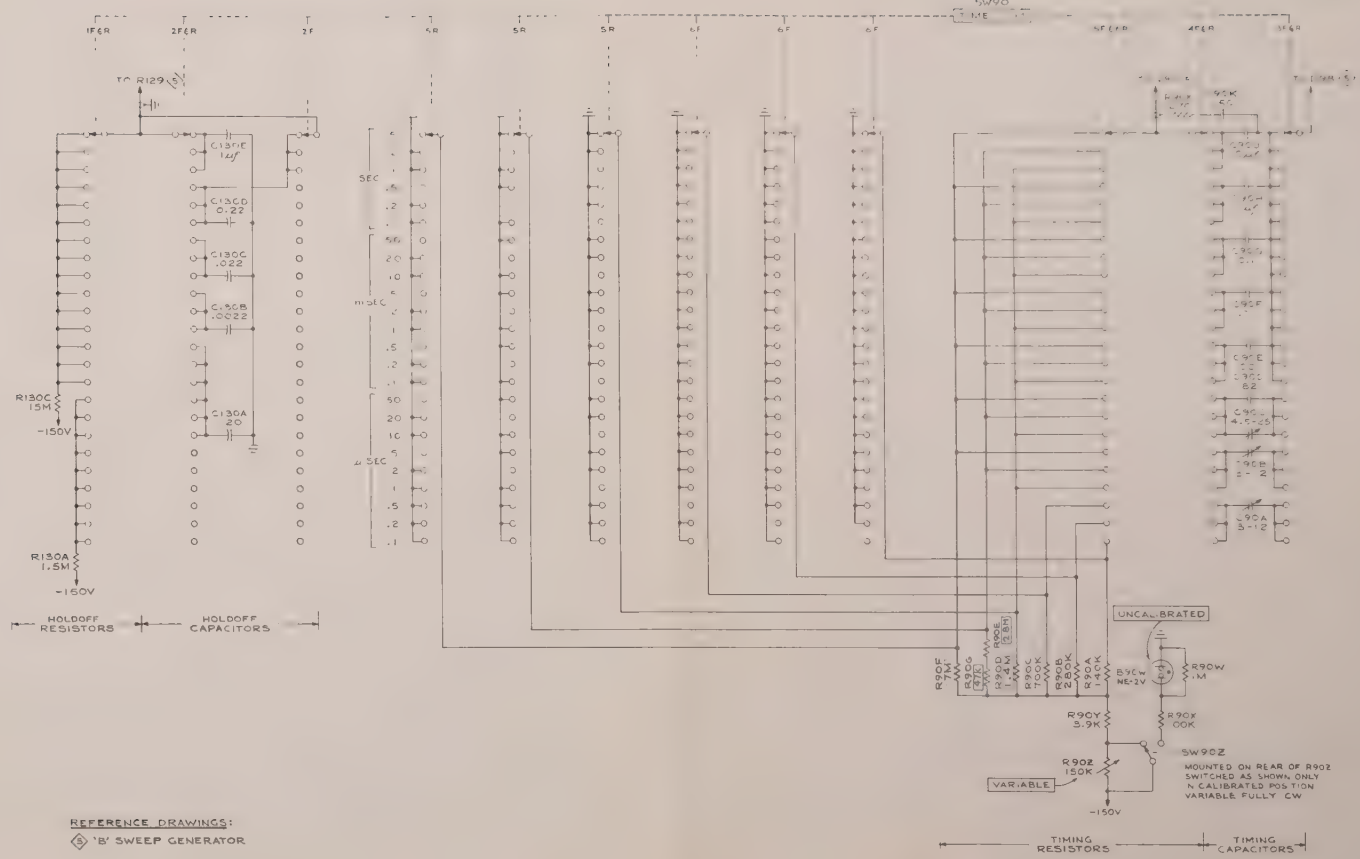

'B' SWEEP GENERATOR (S/N 100-499)




TPYE RM546 OSCILLOSCOPE

CM0 367

'B' SWEEP GENERATOR (S/N 500-UP)




REFERENCE DRAWINGS:
⑤ 'B' SWEEP GENERATOR

TYPE RM546 OSCILLOSCOPE

8

MRH
26

'B' SWEEP TIMING SWITCH ⑥

## DELAY PICKOFF

WAVEFORMS AND VOLTAGE READINGS were obtained under the following conditions:

TIME BASE A —
- 'A' TRIGGER INPUT Signal ..... None
- 'A' TRIGGERING LEVEL ..... ccw
- TIME/CM ..... .1 mSEC/CM
- VARIABLE ..... CALIBRATED

SINGLE SWEEP Switch ..... NORMAL

MAIN TIME BASE (B) —
- TRIGGERING LEVEL ..... +45°; push in
- TRIGGERING:
  - MODE ..... TRIG
  - SLOPE ..... +
  - COUPLING ..... AC
  - SOURCE ..... EXT
- TIME/CM ..... .1 mSEC/CM
- VARIABLE ..... CALIBRATED

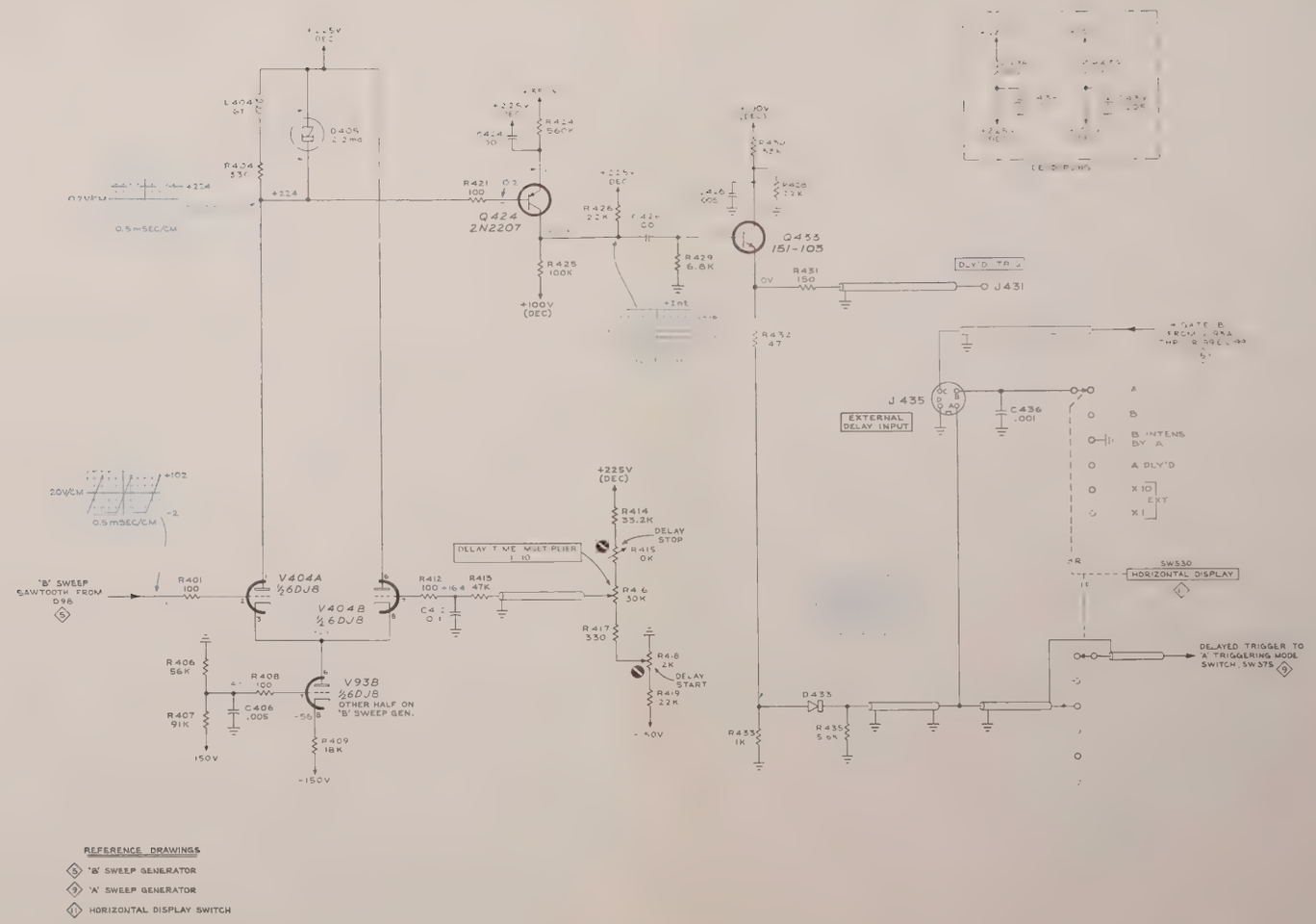
DELAY-TIME MULTIPLIER ..... 2.00

POWER ..... ON

WAVEFORM CONDITIONS —
- 'A' TRIGGERING MODE ..... AUTO
- HORIZONTAL DISPLAY ..... A DLY'D
- 'B' TRIGGER INPUT Signal ..... 10 Volts P-P Calibrator
- AMPLITUDE CALIBRATOR ..... 10 Volts

QUIESCENT VOLTAGE CONDITIONS —
- 'A' TRIGGERING MODE ..... TRIG
- HORIZONTAL DISPLAY ..... B
- 'B' TRIGGER INPUT Signal ..... None

Also see IMPORTANT note on Block Diagram.




REFERENCE DRAWINGS
- (5) 'B' SWEEP GENERATOR
- (9) 'A' SWEEP GENERATOR
- (1) HORIZONTAL DISPLAY SWITCH

## 'A' SWEEP TRIGGER

WAVEFORMS AND VOLTAGE READINGS were obtained under the following conditions:

TIME BASE A —
TRIGGERING:
MODE ..... TRIG
SLOPE ..... +
COUPLING ..... AC
SOURCE ..... EXT

MAIN TIME BASE (B) —
TRIGGER INPUT Signal ..... None
MODE ..... TRIG
SOURCE ..... EXT

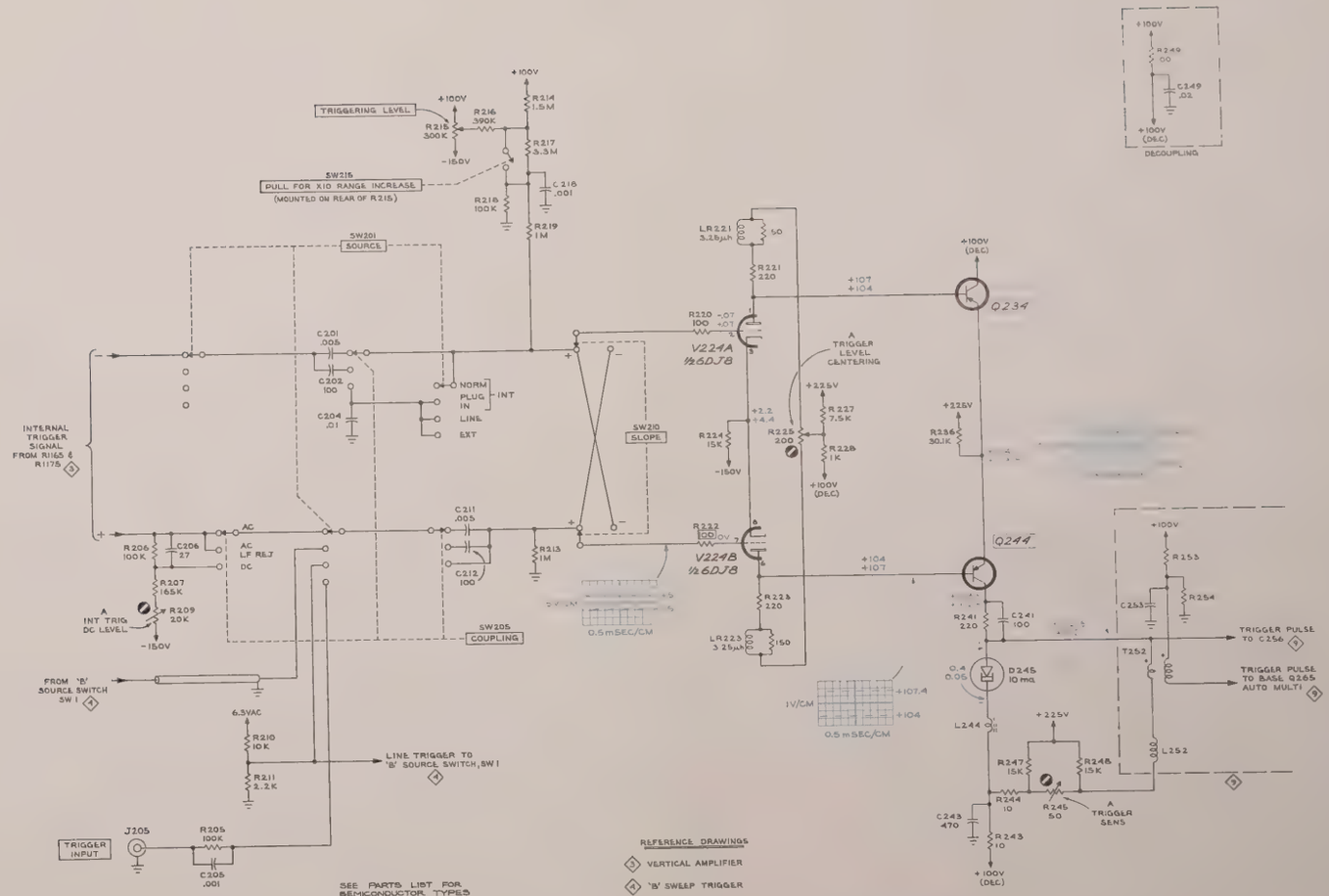
HORIZONTAL DISPLAY ..... A

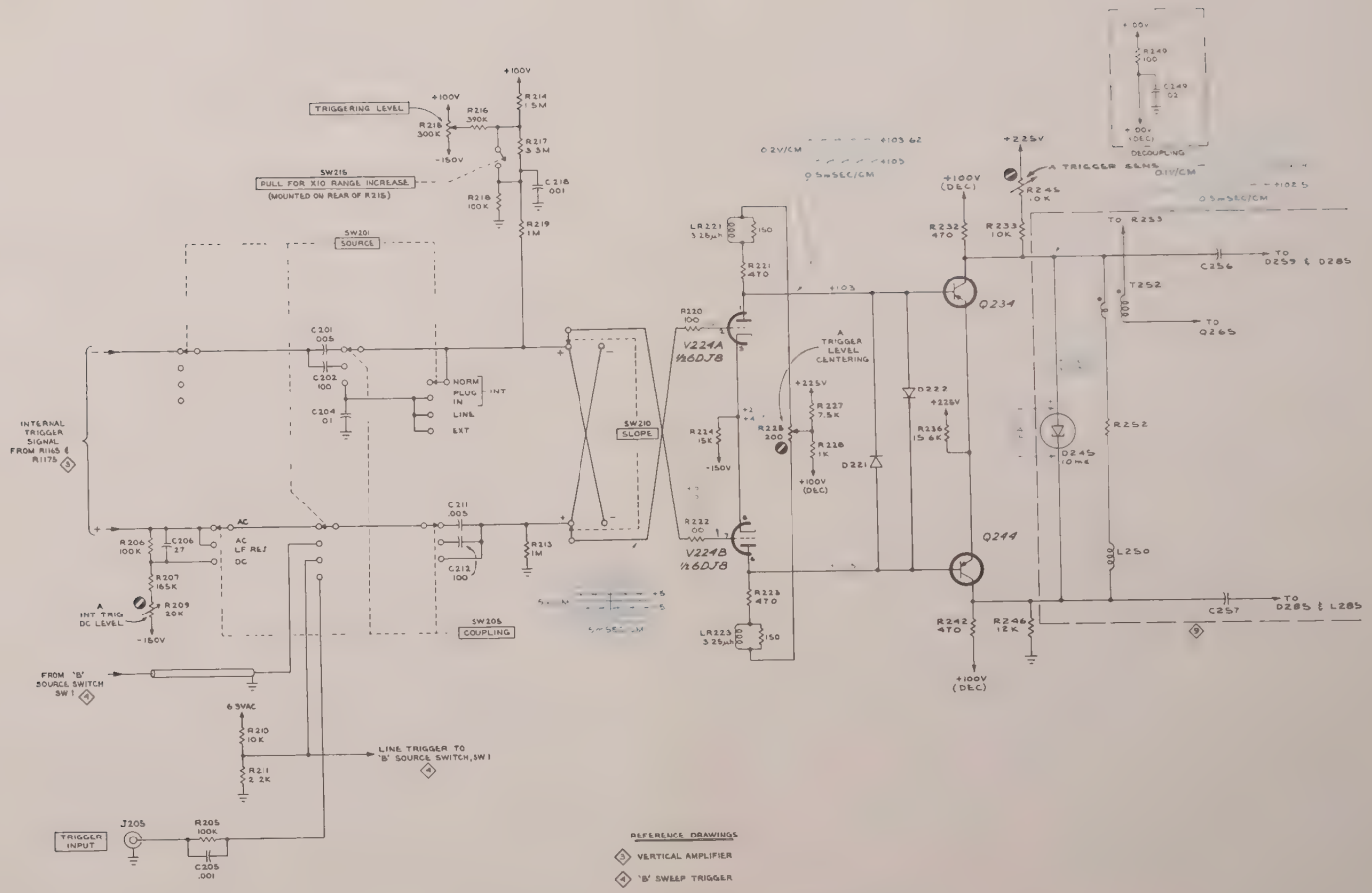
POWER ..... ON

WAVEFORM CONDITIONS —
'A' TRIGGER INPUT Signal ..... 10 Volts P-P Calibrator
'A' TRIGGERING LEVEL ..... +45°; knob pushed in
'A' TIME/CM ..... .1 mSEC
AMPLITUDE CALIBRATOR ..... 10 Volts

QUIESCENT VOLTAGE CONDITIONS —
'A' TRIGGER INPUT Signal ..... None
'A' TRIGGERING LEVEL with knob pushed in:
Upper Voltage Readings ..... ccw
Lower Voltage Readings ..... cw

Also see IMPORTANT note on Block Diagram.






REFERENCE DRAWINGS

- ◇3 VERTICAL AMPLIFIER
- ◇4 'B' SWEEP TRIGGER
- ◇9 'A' SWEEP GENERATOR

SEE PARTS LIST FOR SEMICONDUCTOR TYPES

TPYE RM5460SCILLOSCOPE

CHD 9-07

'A' SWEEP TRIGGER ◇8
(S/N 500-UP)

## 'A' SWEEP GENERATOR

WAVEFORMS AND VOLTAGE READINGS were obtained under the following conditions:

TIME BASE A —
- TRIGGERING LEVEL ..... +45°; knob pushed in
- TRIGGERING:
  - SLOPE ..... +
  - COUPLING ..... AC
  - SOURCE ..... EXT
- TIME/CM ..... .1 mSEC
- VARIABLE ..... CALIBRATED

HORIZONTAL DISPLAY ..... A

SINGLE SWEEP Switch ..... NORMAL

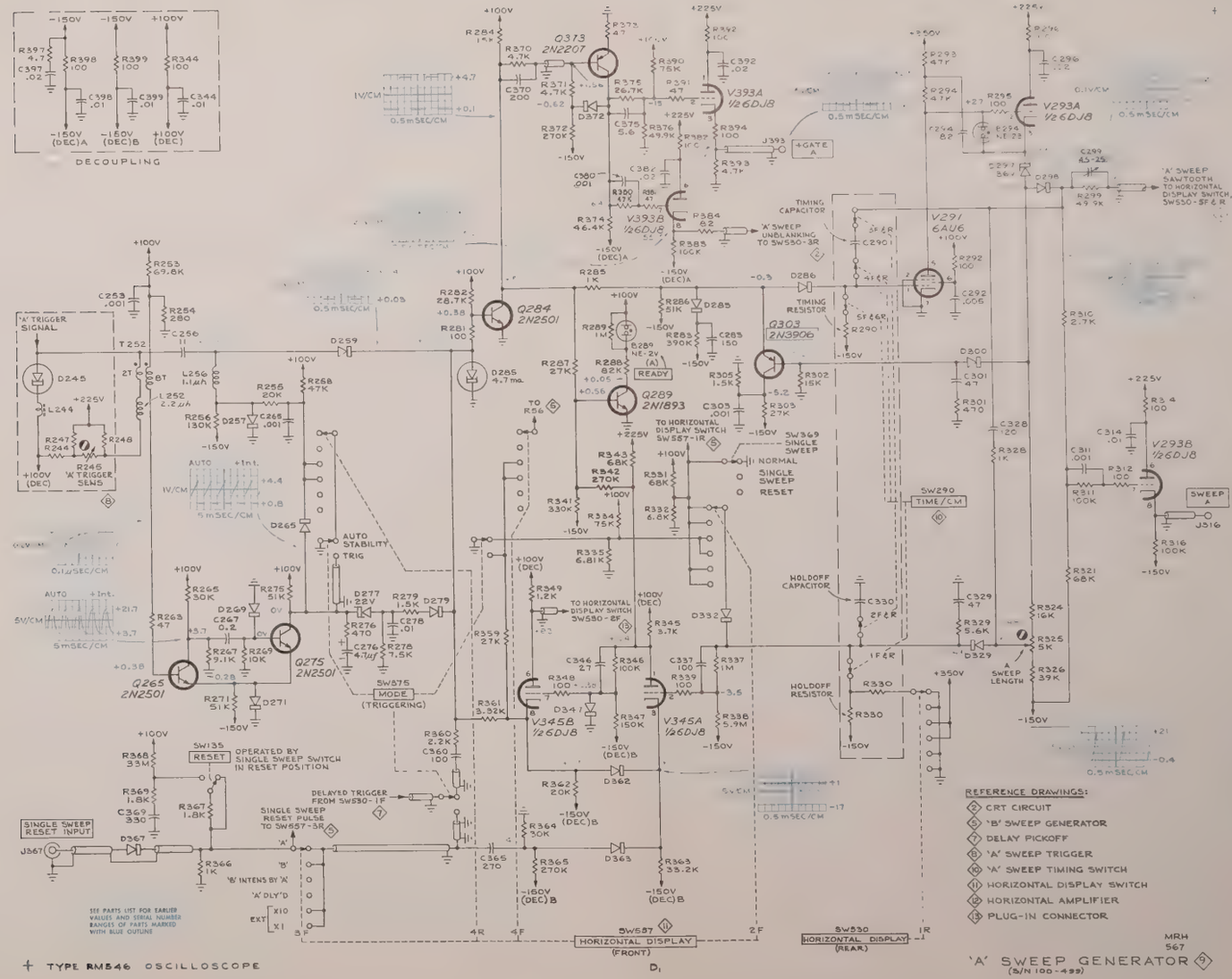
MAIN TIME BASE (B) —
- TRIGGER INPUT Signal ..... None
- TRIGGERING:
  - MODE ..... TRIG
  - SOURCE ..... EXT

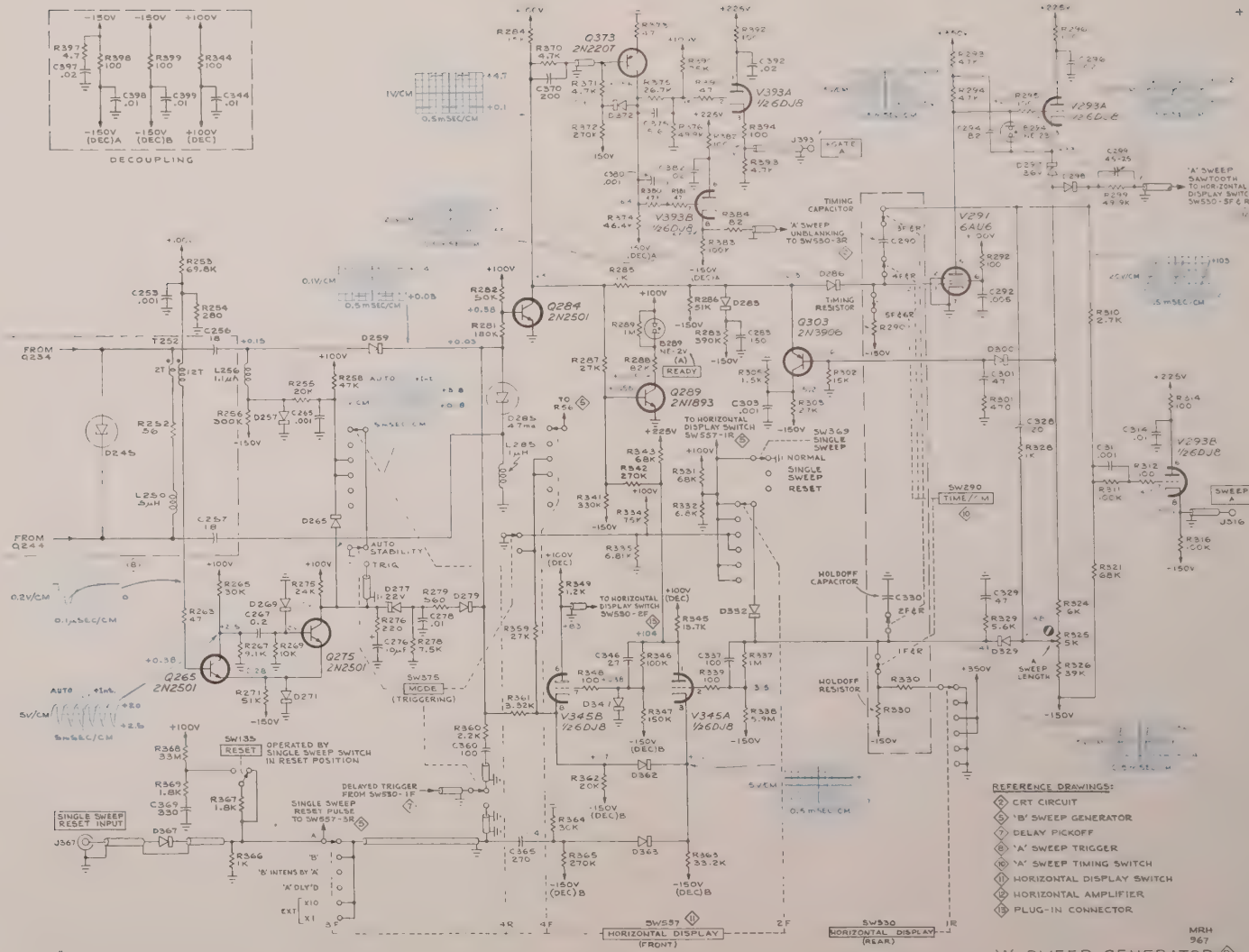
POWER ..... ON

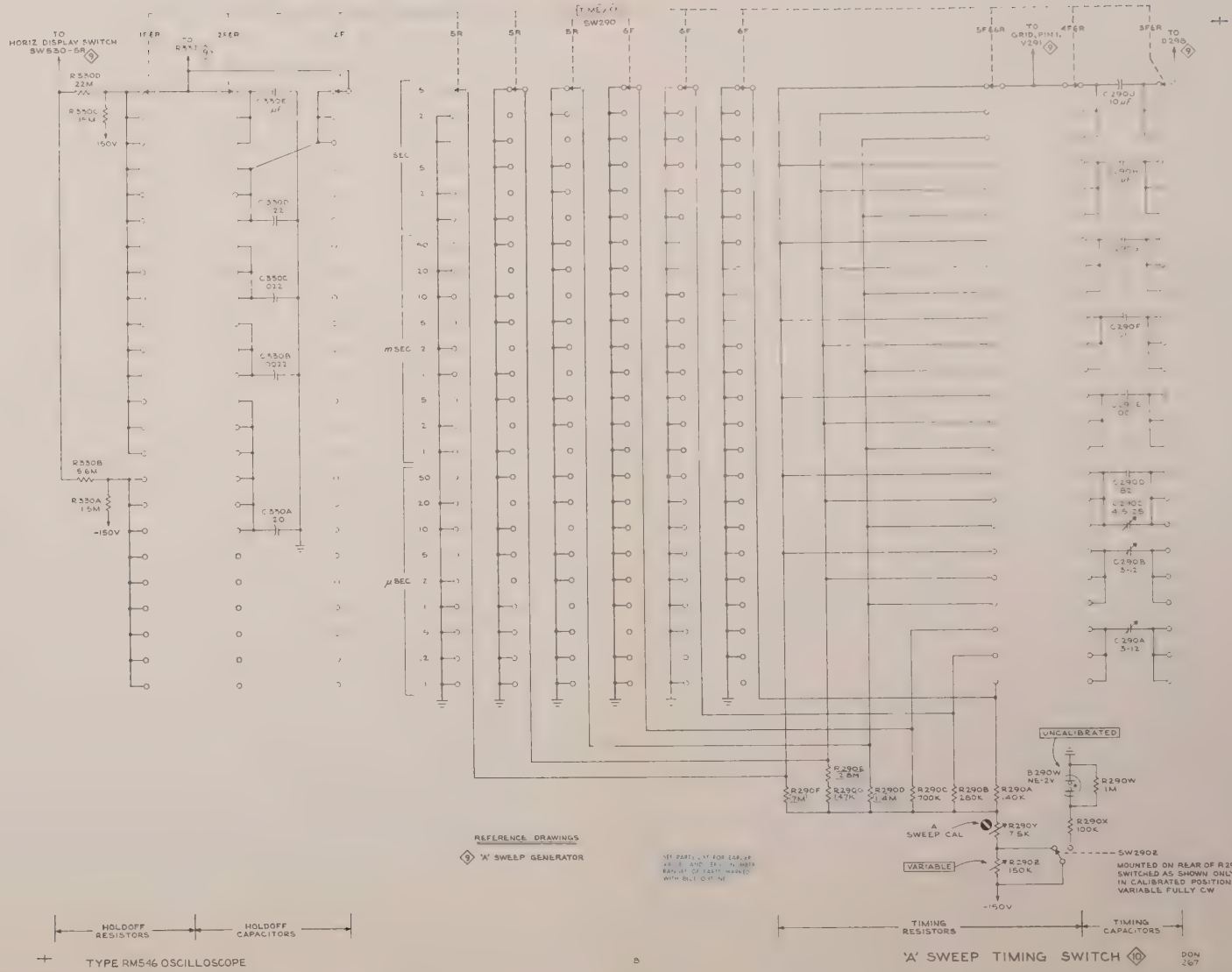
WAVEFORM CONDITIONS —
- 'A' TRIGGER INPUT Signal ..... 10 Volts P-P Calibrator
- 'A' TRIGGERING MODE ..... TRIG (AUTO for waveforms at collectors of Q265 and Q275).
- AMPLITUDE CALIBRATOR ..... 10 Volts

QUIESCENT VOLTAGE CONDITIONS
- 'A' TRIGGER INPUT Signal ..... None
- 'A' TRIGGERING MODE ..... TRIG

Also see IMPORTANT note on Block Diagram.



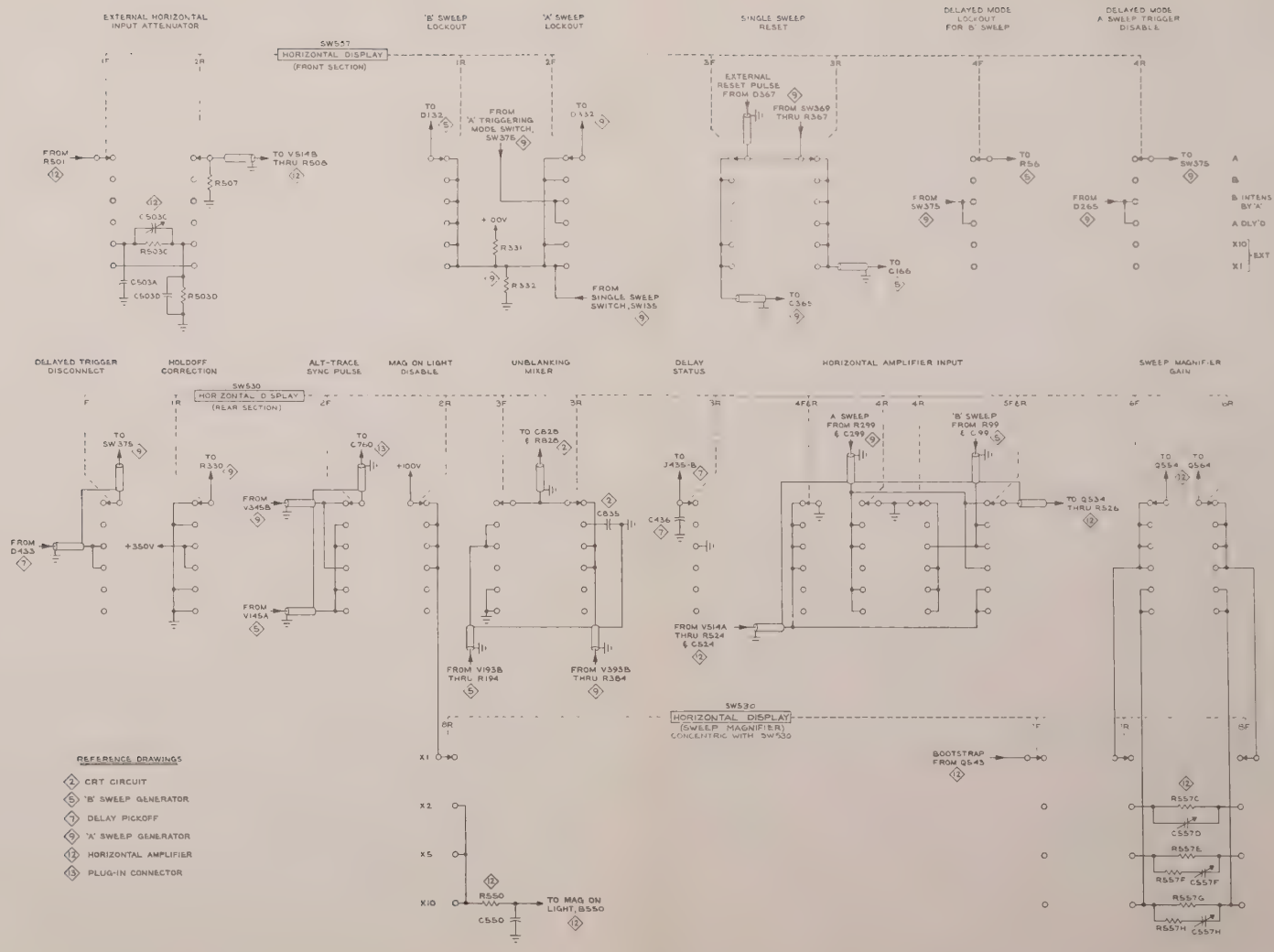

DECOUPLING
Q373 2N2207
V393A 1/2 6DJ8
V393B 1/2 6DJ8
Q284 2N2501
Q289 2N1893
Q303 2N3906
V291 6AU6
V293A 1/2 6DJ8
V293B 1/2 6DJ8
Q275 2N2501
Q265 2N2501
V345A 1/2 6DJ8
V345B 1/2 6DJ8
TIMING CAPACITOR
TIMING RESISTOR
HOLDOFF CAPACITOR
HOLDOFF RESISTOR
'A' SWEEP UNBLANKING TO SW550-3R
'A' SWEEP SAWTOOTH TO HORIZONTAL DISPLAY SWITCH, SW550-3F & R
TO HORIZONTAL DISPLAY SWITCH SW557-1R
SW369 SINGLE SWEEP
NORMAL
SINGLE SWEEP
RESET
SWZ90 TIME / M
SWEEP LENGTH
READY
AUTO STABILITY
TRIG
SW375 MODE (TRIGGERING)
SW135 RESET
OPERATED BY SINGLE SWEEP SWITCH IN RESET POSITION
DELAYED TRIGGER FROM SW550-1F
SINGLE SWEEP RESET PULSE TO SW557-3R
SINGLE SWEEP RESET INPUT
'B' INTENS BY 'A'
'A' DLY'D
EXT X10 X1
TO HORIZONTAL DISPLAY SWITCH SW550-8F
FROM Q234
FROM Q244
SW557 HORIZONTAL DISPLAY (FRONT)
SW330 HORIZONTAL DISPLAY (REAR)
REFERENCE DRAWINGS:
2 CRT CIRCUIT
5 'B' SWEEP GENERATOR
7 DELAY PICKOFF
8 'A' SWEEP TRIGGER
10 'A' SWEEP TIMING SWITCH
11 HORIZONTAL DISPLAY SWITCH
12 HORIZONTAL AMPLIFIER
13 PLUG-IN CONNECTOR
MRH 967
'A' SWEEP GENERATOR 9
S/N 500-UP
TYPE RM546 OSCILLOSCOPE




TYPE RM546 OSCILLOSCOPE

'A' SWEEP TIMING SWITCH

DON 267




TYPE RM546 OSCILLOSCOPE

CMD 264

HORIZONTAL DISPLAY SWITCH (1)

## HORIZONTAL AMPLIFIER

WAVEFORM AND VOLTAGE READINGS were obtained under the following conditions:

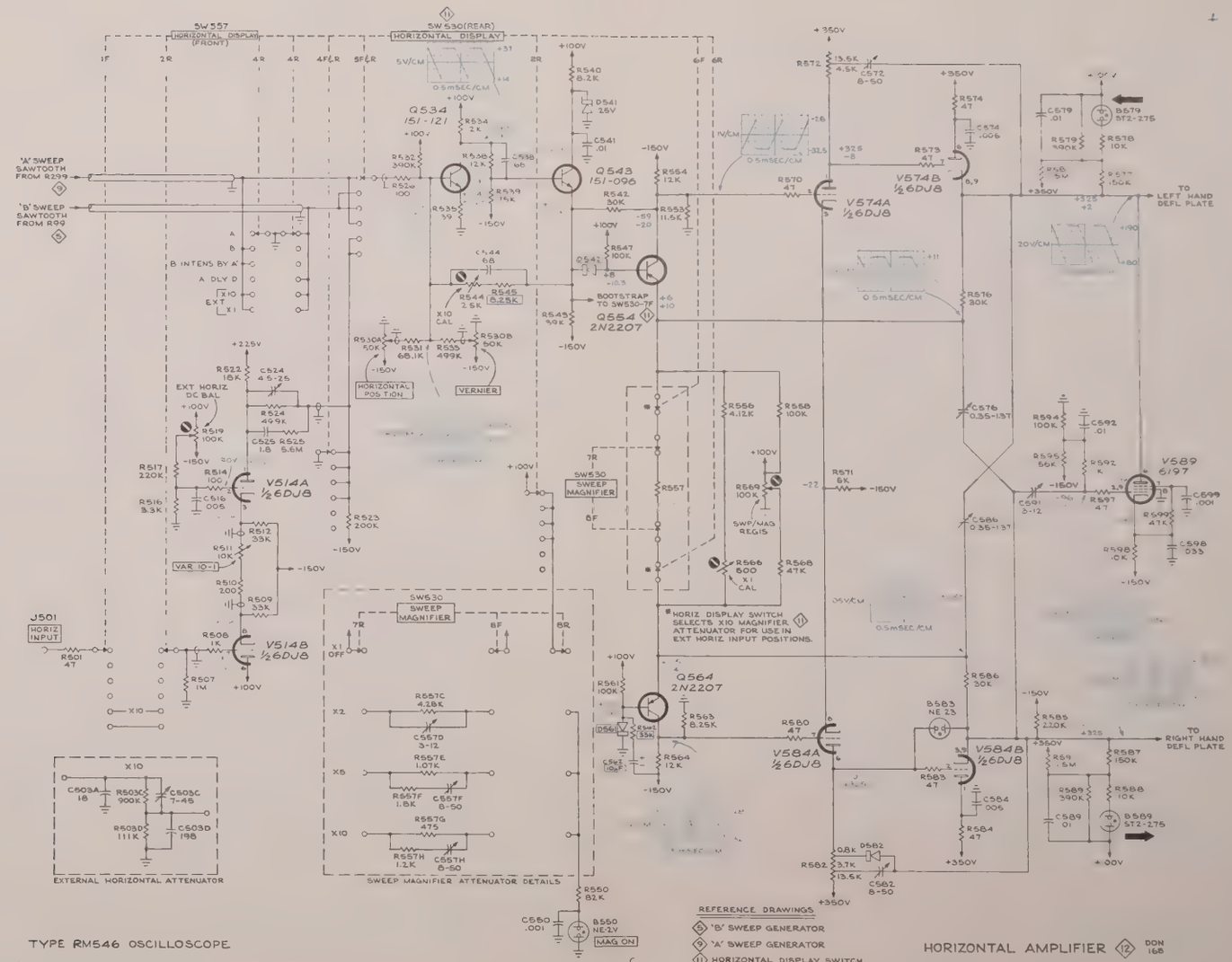
MAIN TIME BASE (B) —
- TRIGGERING LEVEL ..... +45°; pushed in
- TRIGGERING:
  - MODE ..... TRIG
  - SLOPE ..... +
  - COUPLING ..... AC
  - SOURCE ..... EXT
- TIME/CM ..... .1 mSEC/CM
- VARIABLE (TIME/CM) ..... CALIBRATED
- SWEEP MAGNIFIER ..... X1
- HORIZONTAL POSITION (VERNIER) .. ccw

INTENSITY ..... Normal

WAVEFORM CONDITIONS —
- 'B' TRIGGER INPUT Signal ..... 10 Volts P-P Calibrator
- AMPLITUDE CALIBRATOR ..... 10 Volts
- HORIZONTAL DISPLAY ..... B
- SWEEP MAGNIFIER ..... X1
- HORIZONTAL POSITION ..... Centered

QUIESCENT VOLTAGE CONDITIONS —
- HORIZ INPUT Signal ..... None
- HORIZONTAL DISPLAY ..... Ext X1
- HORIZONTAL POSITION:
  - Upper Voltage Readings ..... ccw
  - Lower Voltage Readings ..... cw

Also see IMPORTANT note on Block Diagram.




TYPE RM546 OSCILLOSCOPE

HORIZONTAL AMPLIFIER 12 DON 168

## SYNC AMP.

WAVEFORM AND VOLTAGE READINGS were obtained under the following conditions:

HORIZONTAL DISPLAY ..... B

SINGLE SWEEP Switch ..... NORMAL

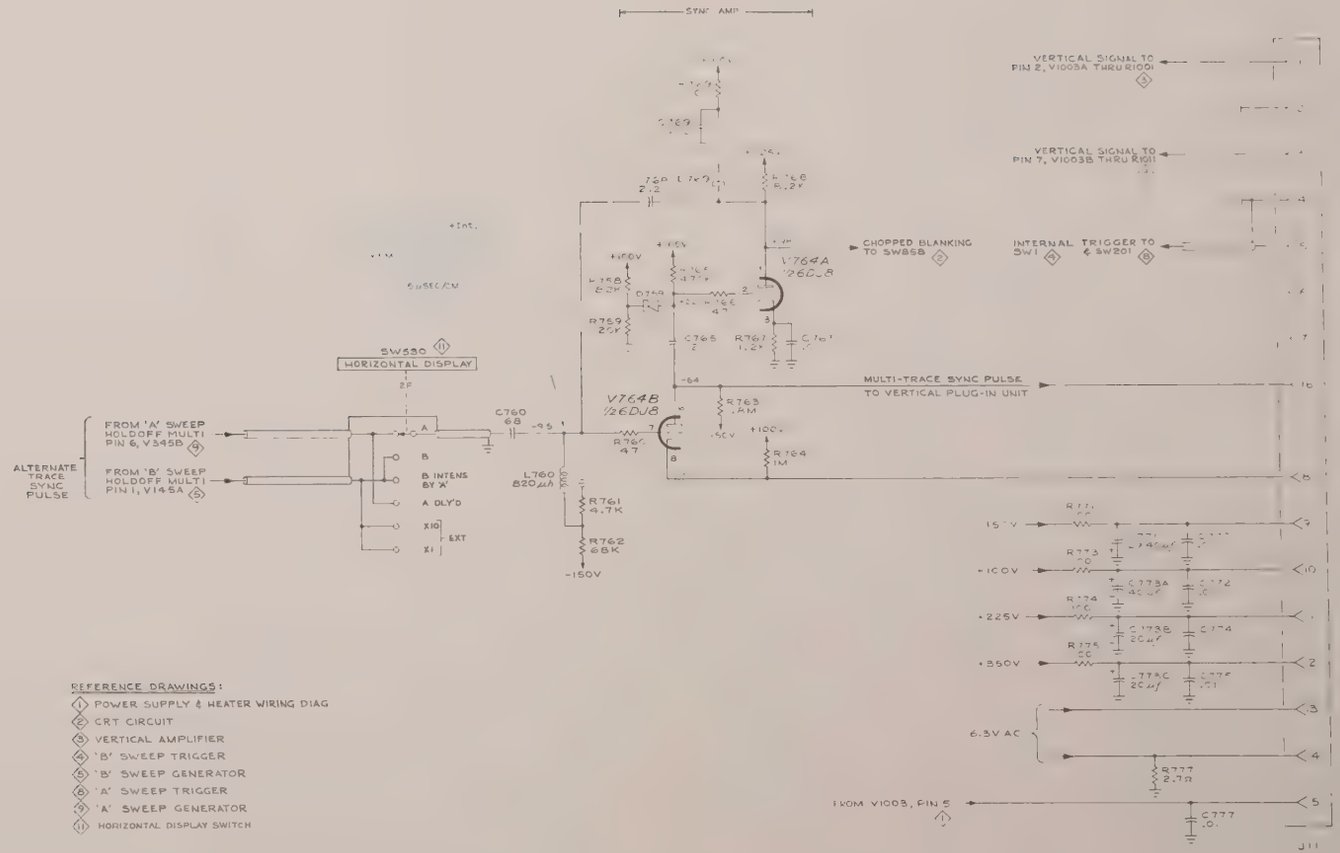
MAIN TIME BASE (B) —
- TRIGGER INPUT Signal ..... None
- TRIGGERING LEVEL ..... cw
- TRIGGERING SOURCE ..... EXT
- TIME/CM ..... 50 μSEC
- VARIABLE ..... CALIBRATED

POWER ..... ON

WAVEFORM CONDITIONS —
- 'B' TRIGGERING MODE ..... AUTO

QUIESCENT VOLTAGE CONDITIONS —
- 'B' TRIGGERING MODE ..... TRIG

Also see IMPORTANT note on Block Diagram.




REFERENCE DRAWINGS:
- (1) POWER SUPPLY & HEATER WIRING DIAG
- (2) CRT CIRCUIT
- (3) VERTICAL AMPLIFIER
- (4) 'B' SWEEP TRIGGER
- (5) 'B' SWEEP GENERATOR
- (6) 'A' SWEEP TRIGGER
- (7) 'A' SWEEP GENERATOR
- (11) HORIZONTAL DISPLAY SWITCH

MRH 664

PLUG-IN CONNECTOR (13)

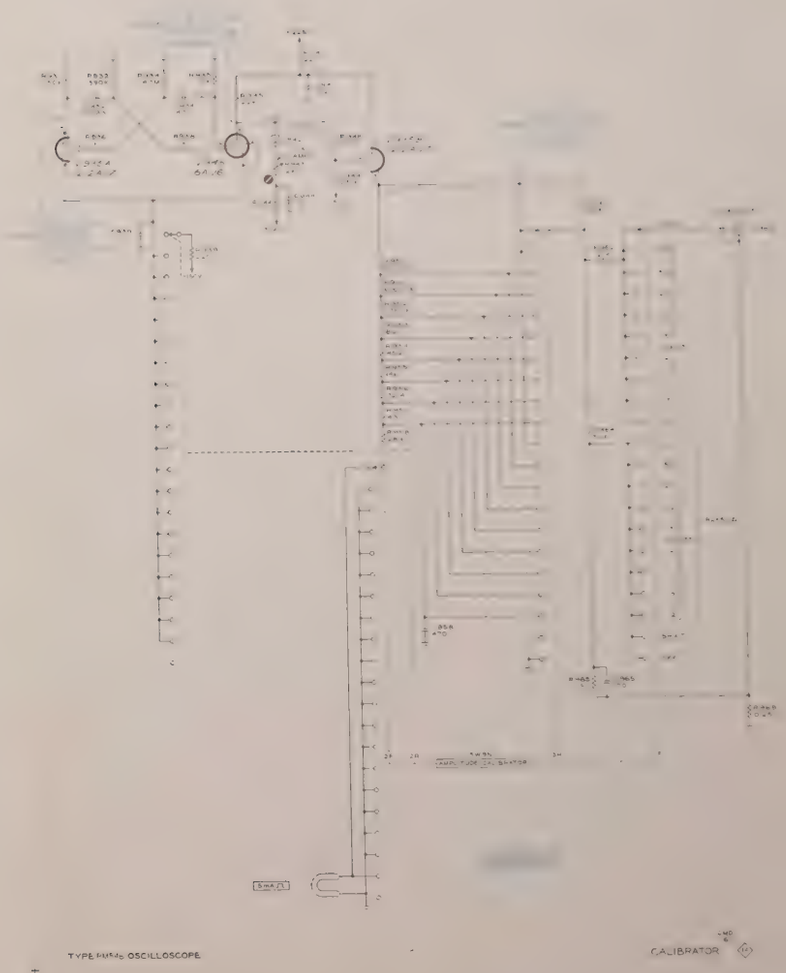
## CALIBRATOR

WAVEFORM AND DYNAMIC VOLTAGE READINGS were obtained under the following conditions:

AMPLITUDE CALIBRATOR ..... 10 Volts

POWER . . . . . ON

Also see IMPORTANT note on Block Diagram.



# SECTION 7
# INSTALLATION

## Mounting Methods (Figs. 7-1 and 7-2)

This instrument will fit most 19-inch wide racks whose dimensions conform to EIA specifications. The instrument cabinet is intended to be fastened directly to the front rails of a relay rack or a cabinet rack by means of the hardware supplied with the instrument. For example, Fig. 7-1 shows the instrument cabinet installed in a cabinet rack. The rear of the instrument normally needs no support, providing it is not subjected to any great amount of shock or vibration. If the instrument is to be subjected to severe shock or vibration it will be necessary to rigidly mount the rear of the cabinet to the rack. Fig. 7-1 shows the rear of the cabinet mounted to the rack with hardware provided in modification kit 016-060.

The instrument is locked into its cabinet by means of four slotted LOCK knobs on the front panel. When these knobs are turned to release the instrument, it can be pulled out of the cabinet like a drawer to its fully extended position (see Fig. 7-2) and then tilted up or down and locked in one of several positions—horizontal, or 45°, 90°, and 105° from horizontal. These various positions permit many routine maintenance functions to be performed without completely removing the instrument from the rack.

## Instrument Dimensions

The last pullout page in this section shows dimensional drawings of the instrument exclusive of the plug-in unit and probes.

## Rack Dimensions

Width — A standard 19" rack may be used. The dimension of opening between the front rails of the rack must be at least 17⅞".

Depth — For circulation of cooling air, allow at least 3" behind the rear and at least 2" between each side of the instrument cabinet and any enclosure on the rack. The space allowed can be reduced slightly so long as the instrument receives at least 250 cu. ft/min of air not exceeding 50°C in temperature.

In addition to the area left at the rear of the oscilloscope, about four feet should be left free in front of the instrument rack. This space will permit extending the instrument fully out of the cabinet and still have working room in front.

## Rackmounting (Fig. 7-1)

To mount the instrument cabinet directly to the front and rear rails of the rack as shown in Fig. 7-1, proceed as follows:

1. Select the height on the rack where the top of the front panel is to be and mark both front rails.
2. Measure down 1½ inches from the marks placed in step 1. Mark this point on both front rails. This mark is the location of the top mounting screw on each side of the cabinet.
3. Measure down 11 inches from the point found on each rail in step 2. This is the location of the bottom screws on each side of the cabinet.
4. Hold the cabinet in place and mount it with the screws provided.
5. If the instrument is to be subjected to severe shock or vibration, it will be necessary to attach the rear of the cabinet to the rack rails, using the brackets supplied in modification kit 016-060. If the amount of shock or vibration is small, additional mounting screws attaching the cabinet to the rack may provide enough support.

## Slideout Tracks (Fig. 7-2)

The slideout tracks for the instrument consist of two assemblies, one each for the right and left sides. Each assembly consists of three sections as illustrated in Fig. 7-3. The stationary section attaches to the cabinet front and rear, the chassis section attaches to the instrument, and the intermediate section fits between the other two sections to allow the oscilloscope to fully extend out of the rack.

The stationary and intermediate sections for both sides of the cabinet rack are a matched set and should not be separated.

## Adjustments

To adjust the slideout tracks for smooth operation, proceed as follows:

1. Insert the instrument into the cabinet as shown in Fig. 7-4.
2. If the oscilloscope does not slide smoothly the detent assembly of the chassis sections may not be parallel to the bottom of the instrument and/or the eccentric pivot screws may not be set evenly so the slides are not parallel to each other. Adjust as shown in Fig. 7-5.

NOTE

**If the eccentric pivot screw does not turn freely when adjusting it, the slot in the detent plate is fitting too tightly around the ¼" diameter roll pin. This condition can be corrected as follows: Remove the nut, lockwasher and flat washer from the eccentric pivot screw. Remove the outer slide, pivot screw and dial plate. Using a round file, slightly enlarge the slot in the dial plate where the roll pin fits. Then re-mount the parts.**

## Maintenance

The slideout tracks require no lubrication. The special gray finish on the sliding parts is a permanent lubricant.

## Front Panel Alignment and Anchor Castings (Fig. 7-1)

The four alignment and anchor castings are used to secure the instrument into the cabinet. It is possible to adjust them to position the front panel up or down, against or slightly away from the cabinet. The effect of the adjustment can only be seen when the instrument is secured in the cabinet.

## Adjustment

This adjustment must be performed before mounting the cabinet and instrument into a rack.

1. Turn the slotted LOCK knobs to release the oscilloscope from the cabinet.
2. Pull the instrument about 2 inches out of the cabinet.
3. Loosen the three screws holding the casting to be adjusted.
4. Insert the instrument all the way into the cabinet and engage the appropriate thumb screw into the casting being adjusted. Engaging the thumb screw into the casting will position it to the proper position.
5. Tighten the three screws holding the casting.

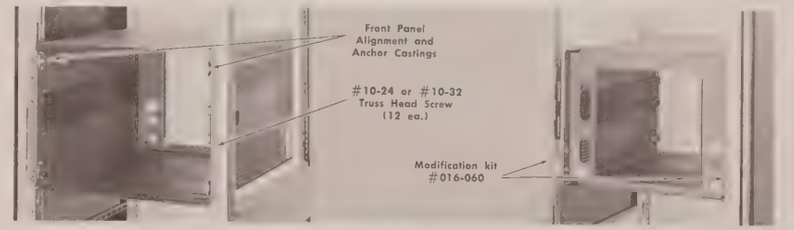



Fig. 7-1. Front and rear views of the instrument cabinet mounting.

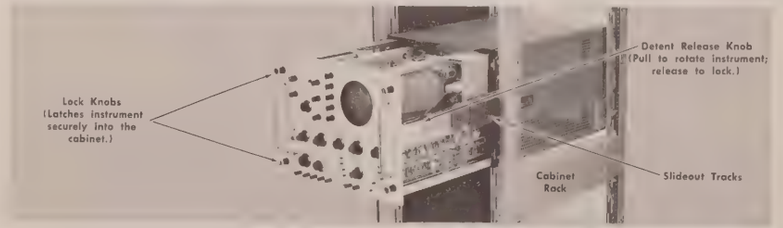

Lock Knobs (Latches instrument securely into the cabinet.)
Detent Release Knob (Pull to rotate instrument; release to lock.)
Cabinet Rack
Slideout Tracks

Fig. 7-2. Instrument extended from its cabinet.

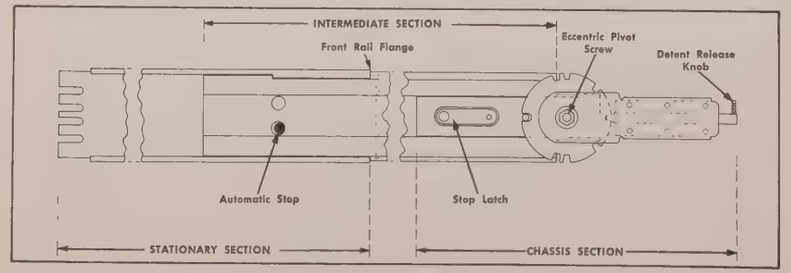



Fig. 7-3. Illustration showing the slideout track assembly for the right side.

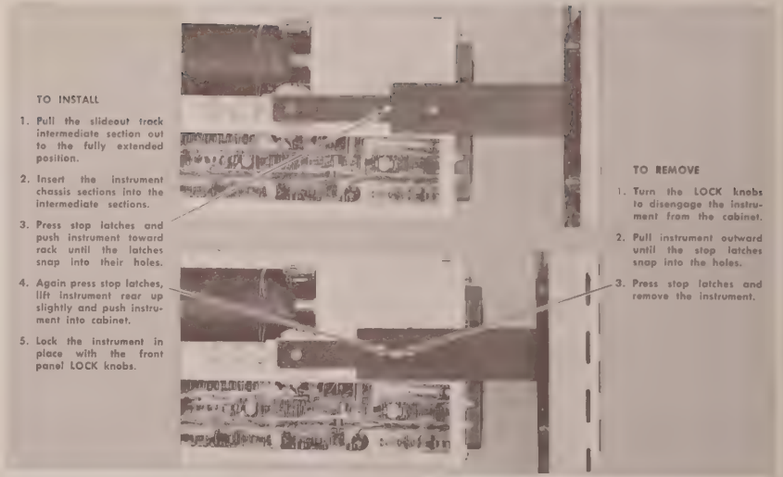
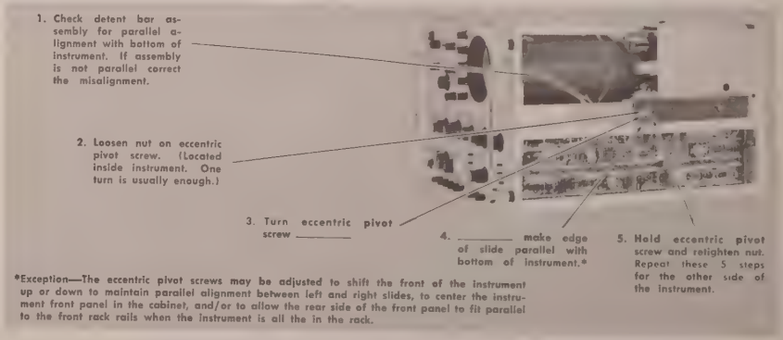

TO INSTALL
1. Pull the slideout track intermediate section out to the fully extended position.
2. Insert the instrument chassis sections into the intermediate sections.
3. Press stop latches and push instrument toward rack until the latches snap into their holes.
4. Again press stop latches, lift instrument rear up slightly and push instrument into cabinet.
5. Lock the instrument in place with the front panel LOCK knobs.
TO REMOVE
1. Turn the LOCK knobs to disengage the instrument from the cabinet.
2. Pull instrument outward until the stop latches snap into the holes.
3. Press stop latches and remove the instrument.

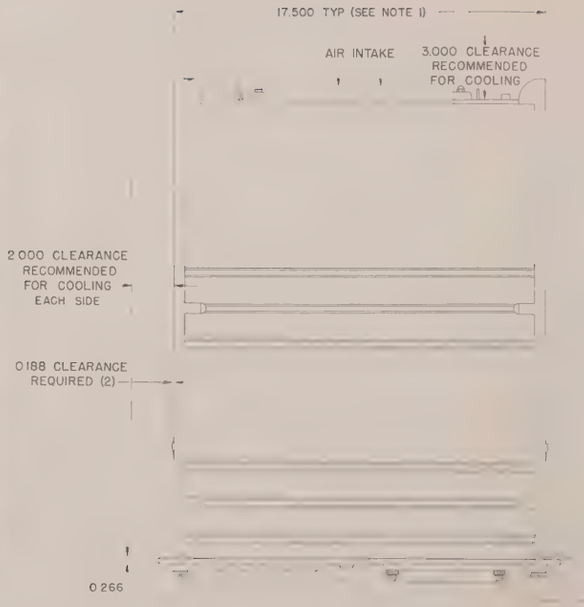
Fig. 7-4. Installing and removing the instrument

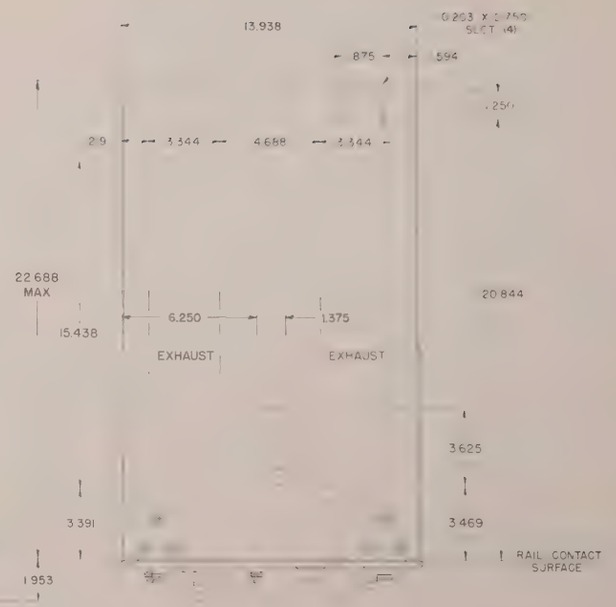

1. Check detent bar assembly for parallel alignment with bottom of instrument. If assembly is not parallel correct the misalignment.
2. Loosen nut on eccentric pivot screw. (Located inside instrument. One turn is usually enough.)
3. Turn eccentric pivot screw _____
4. _____ make edge of slide parallel with bottom of instrument.*
5. Hold eccentric pivot screw and retighten nut. Repeat these 5 steps for the other side of the instrument.

*Exception—The eccentric pivot screws may be adjusted to shift the front of the instrument up or down to maintain parallel alignment between left and right slides, to center the instrument front panel in the cabinet, and/or to allow the rear side of the front panel to fit parallel to the front rack rails when the instrument is all the in the rack.

Fig. 7-5. Adjusting the chassis sections.

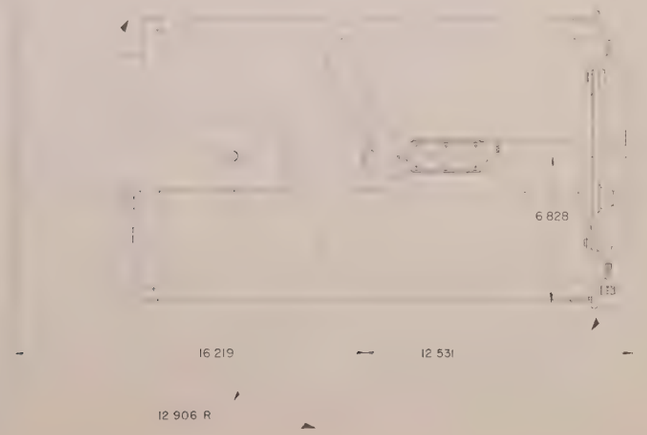
REAR VIEW


17.500 TYP (SEE NOTE 1)
AIR INTAKE
3.000 CLEARANCE RECOMMENDED FOR COOLING
2.000 CLEARANCE RECOMMENDED FOR COOLING EACH SIDE
0.188 CLEARANCE REQUIRED (2)
0.266




SEE SECTION DETAIL "A"

TILT POSITIONS:
45°, 90°, & 105°
ABOVE AND BELOW
THE HORIZONTAL



SECTION DETAIL "A"

RECOMMENDED MOUNTING

NOTES
1 SUBJECT TO APPROXIMATELY ±.0047 DEVIATION
2 ALL DIMENSIONS ARE REFERENCE DIMENSIONS EXCEPT AS NOTED

TYPE RM546

A1

## MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TEXT CORRECTION

Section 3 Circuit Description

Page 3-7 Column 1, paragraph 1

ADD: the heading CIRCUIT OPERATION SN 101-959 to the first paragraph.

Page 3-7 Column 1

ADD: the following before the first paragraph:

CIRCUIT OPERATION SN 960-UP. V24A and V24B form a switching comparator. The voltage level at which the comparator switches is set by the B TRIGGERING LEVEL control R15. V24 drives Q34 and Q44, which form a current type switching comparator. Q34 and Q44 drive tunnel diode D45 which in turn drives sweep gating tunnel diode D85.

If no triggering signal is applied to V24 the stage consisting of V24A and V24B is unbalanced. One section (which one depends upon the setting of the B SLOPE and B TRIGGERING LEVEL controls) is conducting more current than the other. The voltages at the plates of V24A and V24B should therefore be different. However, diodes D21 and D22 clamp the two plate voltages to within 0.3 volt of each other, with the plate of the section which is conducting the most current being the most negative.

The second stage, made up of Q34 and Q44, is also unblanced. The transistor whose base is the most negative conducts most of the current supplied by R36. This current is not sufficient to cause the conducting transistor to saturate. The conducting transistor merely acts as a constant current source.

Tunnel diode D45 is biased to its low voltage state by current through R32, R33, R45, and R42. If the comparator stages are unbalanced in such a manner as to cause Q34 to conduct, an additional current flows through D45. This additinnal current biases D45 to its high voltage state (see Fig. 3-2 for tunnel diode characteristic curve).

When the current through D45 reaches a total of 10 ma the voltage across D45 will suddenly increase to approximately 0.5 volts. This sudden voltage change is coupled to the sweep gating tunnel diode D85 by C56, D59, and C57. C56 differentiates the triggering signal which provides a fast rising pulse for D85. L56 and the low impedance of conducting diode D57 decrease the fall time of the triggering pulse. D59 ensures that D85 is only triggered when D45 turns on, and not when D45 turns off.

# ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

| | | | |
|---|---|---|---|
| D76 | 152-0281-00 | 1N969B | 0.4 W, 22 V, ±5% |
| D97 | 152-0294-00 | 1N3033B | 1 W, 36 V, ±5% |
| D277 | 152-0281-00 | 1N969B | 0.4 W, 22 V, ±5% |
| D297 | 152-0294-00 | 1N3033B | 1 W, 36 V, ±5% |
| D541 | 152-0022-00 | 1N25Z5 | 1 W, 25 V, ±5% |
| D693 | 152-0288-00 | .4M140Z5 | 0.4 W, 24 V, ±5% |
| D1109 | 152-0305-00 | 1N3045B | 1 W, 110 V, ±5% |

TEXT CORRECTION

Section 3 Circuit Description

Page 3-7 Column 1, paragraph 1

ADD: the heading CIRCUIT OPERATION SN 101-959 to the first paragraph.

Page 3-7 Column 1

ADD: the following before the first paragraph:

CIRCUIT OPERATION SN 960-UP. V24A and V24B form a switching comparator. The voltage level at which the comparator switches is set by the B TRIGGERING LEVEL control R15. V24 drives Q34 and Q44, which form a current type switching comparator. Q34 and Q44 drive tunnel diode D45 which in turn drives sweep gating tunnel diode D85.

If no triggering signal is applied to V24 the stage consisting of V24A and V24B is unbalanced. One section (which one depends upon the setting of the B SLOPE and B TRIGGERING LEVEL controls) is conducting more current than the other. The voltages at the plates of V24A and V24B should therefore be different. However, diodes D21 and D22 clamp the two plate voltages to within 0.3 volt of each other, with the plate of the section which is conducting the most current being the most negative.

The second stage, made up of Q34 and Q44, is also unbalanced. The transistor whose base is the most negative conducts most of the current supplied by R36. This current is not sufficient to cause the conducting transistor to saturate. The conducting transistor merely acts as a constant current source.

Tunnel diode D45 is biased to its low voltage state by current through R32, R33, R45, and R42. If the comparator stages are unbalanced in such a manner as to cause Q34 to conduct, an additional current flows through D45. This additional current biases D45 to its high voltage state (see Fig. 3-2 for tunnel diode charcteristic curve).

When the current through D45 reaches a total of 10 ma. the voltage across D45 will suddenly increase to approximately 0.5 volts. This sudden voltage change is coupled to the sweep gating tunnel diode D85 by C56, D59, and C57. C56 differentiates the triggering signal which provides a fast rising pulse for D85.

L56 and the low impedance of conducting diode D57 decrease the fall time of the triggering pulse. D59 ensures that D85 is only triggered when D45 turns on, and not when D45 turns off.

Section 5 CALIBRATION

Page 5-6 and 5-7

CHANGE: Step 12 to Step 12B

ADD: (SN 101 - 962) RM546 (SN 101 - 499) immediately after the last word in the title of the redesignated step 12B.

ADD: The following to precede step 12B.

12A. Adjust A TRIGGER LEVEL CENTERING R225 and A TRIGGER SENS R245--A Sweep Trigger (SN 963-up) FOR RM546 (SN 500-up)

a. Set the AMPLITUDE CALIBRATOR to .1 volts.

NOTE

A 100 mv peak-to-peak signal is used in this portion of the procedure as an adjustment aid only and is not intended to be interpreted as a trigger-amplitude specification that contradicts the one given in the Characteristics section of this manual.

b. Insert a BNC T connector between the CAL OUT connector and the coax cable to the TU-7 Ext Input. Connect another coax cable from the T connector to the A TRIGGER INPUT connector. (The CAL OUT connector should not be connected to the Ext Input connector on the TU-7 and to the A TRIGGER INPUT connector on the oscilloscope.)

Type 546/RM546

c. Set the front-panel controls as follows:

Controls not mentioned may be left as is.

| | |
|---|---|
| INTENSITY | As required for a visible trace |
| FOCUS | As required for a focused trace |
| ASTIGMATISM | As required for a focused trace |

| | |
|---|---|
| SCALE ILLUM | As required for a visible graticule |
| HORIZONTAL POSITON | As required to position trace to the left edge of the graticule |
| VERNIER (HORIZONTAL POSITION) | Midrange |
| HORIZONTAL DISPLAY | A |
| SWEEP MAGNIFIER | X1 (OFF) |
| SINGLE SWEEP Switch | Normal |

Time Base A

| | |
|---|---|
| TRIGGERING LEVEL | 0 |
| TIME/CM | .5 mSEC |
| TRIGGERING | |
| MODE | TRIG |
| SLOPE | + |
| COUPLING | AC |
| SOURCE | EXT |

TU-7

| | |
|---|---|
| Variable | Fully Clockwise |
| Position | Centered |
| Test Function | Low Load |

Test Oscilloscope

| | |
|---|---|
| Input Coupling | AC |
| Volts/Div | .02 |
| Time/Div | .5 mSEC |
| Triggering | |
| Mode | AUTO |
| Slope | + |
| Coupling | AC |
| Source | Internal |

d. Locate the junction of R217, C218, R218 (See Fig. 5-5). Connect a short jumper clip lead

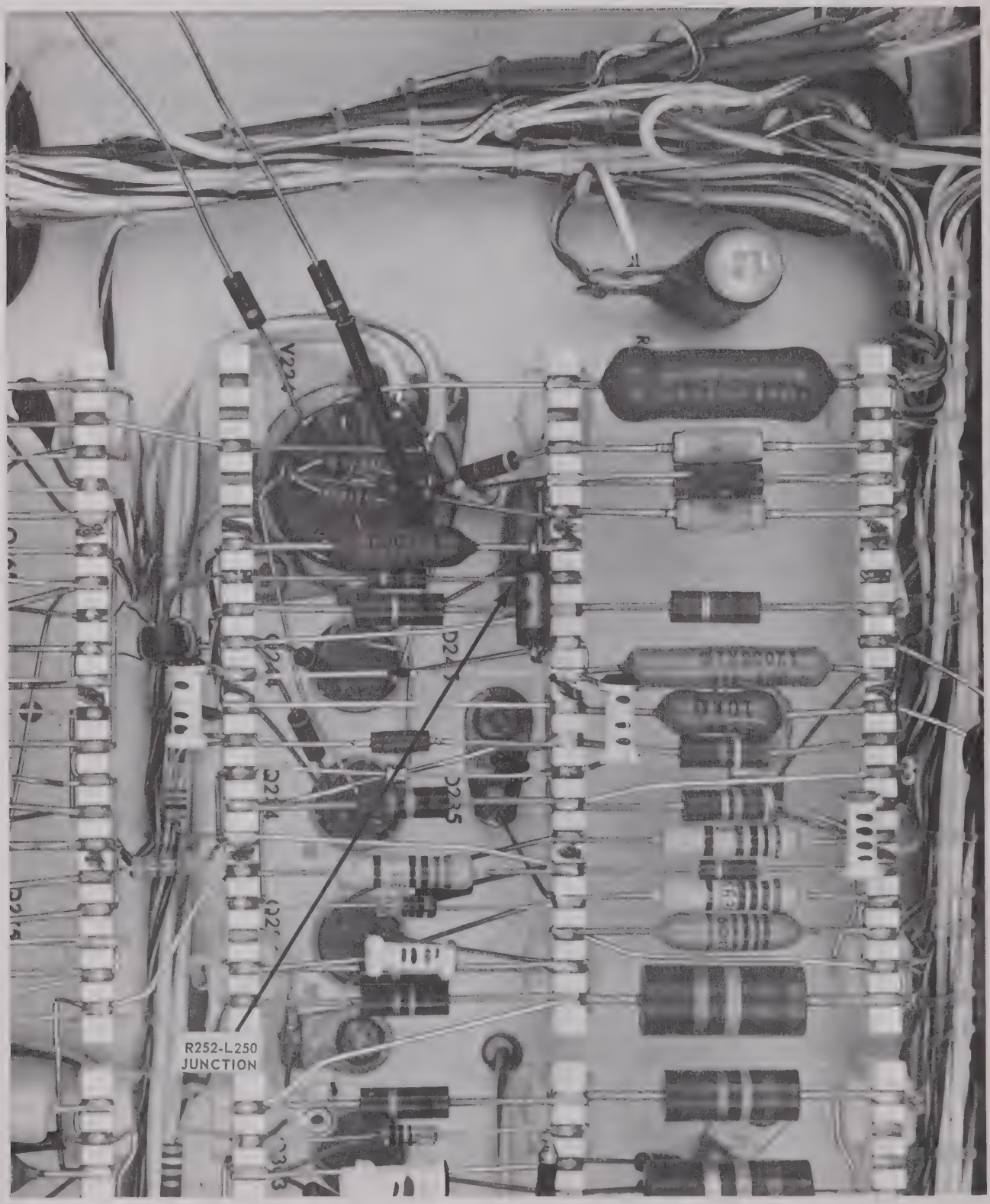



Fig. 1. A Trigger adjustment test point location

between the junction and ground. This jumper disables the A TRIGGERING LEVEL control.

e. Locate the junction of R252 and L250 (See Fig. 1, page 4 of this modification). Connect a 10X probe from the test oscilloscope to this junction.

f. Preset the A TRIGGER LEVEL CENTERING R225 control to midrange and the A TRIG SENS R245 control fully clockwise.

g. Adjust the A TRIGGER LEVEL CENTERING R225 control for a stable display of square waves on the test oscilloscope (the square waves will have an amplitude of approximately 200 mv peak-to-peak). Note that there is a range in the adjustment of R225 through which the square wave display will remain stable. Set R225 approximately in the middle of this range.

h. Change the SLOPE switch to — and readjust R225 if necessary. Continue alternating the position of the SLOPE switch and adjusting R225 until the square wave on the test scope is stable in both positions of the SLOPE switch.

i. Turn the A TRIGGER SENS R245 control counter-clockwise until the square wave on the test oscilloscope just begins to break up. (This will occur where the square wave suddenly reduces in amplitude.) Leave R245 set at this point.

j. Readjust the A TRIGGER LEVEL CENTERING R225 control for a stable square wave display at both positions of the SLOPE switch. (Note that there is a range in the adjustment of R225 over which a stable square wave can be obtained. Set R225 in the center of this range.)

k. Set the AMPLITUDE CALIBRATOR switch to 50 mVOLTS. The amplitude of the square wave display on the test oscilloscope should be reduced to less than 100 millivolts in either position of the SLOPE switch. If the amplitude of the square wave on the test

oscilloscope remains at approximately 200 millivolts, repeat i through k.

1. Disconnect the 10X probe from the junction of R252 and L250.

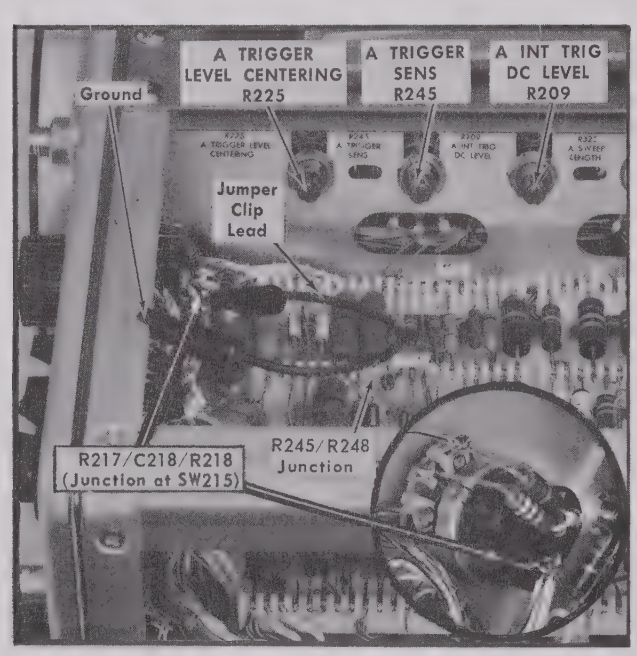



Fig. 2. B Trigger clip-lead connection, adjustment and test point locations.

obtain a stable display when making the check for each A SLOPE switch position.

Pages 5-7, 5-8, and 5-9.
CHANGE: Step 16 to Step 16B
ADD: (SN 101 - 962) RM546 (SN 101 - 499) immediately after the last word in the title of the redesignated step 16B.
ADD: The following to precede step 16B.

16A. Adjust B TRIGGER LEVEL CENTERING R25 and B TRIGGER SENS R45--B Sweep Trigger (SN 963-up) FOR RM546 (SN 500-up)

a. Set the AMPLITUDE CALIBRATOR to .1 volts.

NOTE

A 100 mv peak-to-peak signal is used in this portion of the procedure as an adjustment aid only and is not intended to be interpreted as a trigger-amplitude specification that contradicts the one given in the Characteristics section of this manual.

b. Insert a BNC T connector between the CAL OUT connector and the coax cable to the TU-7 Ext Input. Connect another coax cable from the T connector to the B TRIGGER INPUT connector. (The CAL OUT connector should now be connected to the Ext Input connector on the TU-7 and to the B TRIGGER INPUT connector on the oscilloscope.)

c. Set the front-panel controls as follows:

Type 546/RM546

Controls not mentioned may be left as is

| | |
|---|---|
| HORIZONTAL DISPLAY | B |
| BRIGHTNESS | As required for visible trace |
| **Time Base B** | |
| TRIGGERING LEVEL | 0 |
| TIME/CM | .5 mSEC |
| TRIGGERING | |
| MODE | TRIG |
| SLOPE | + |

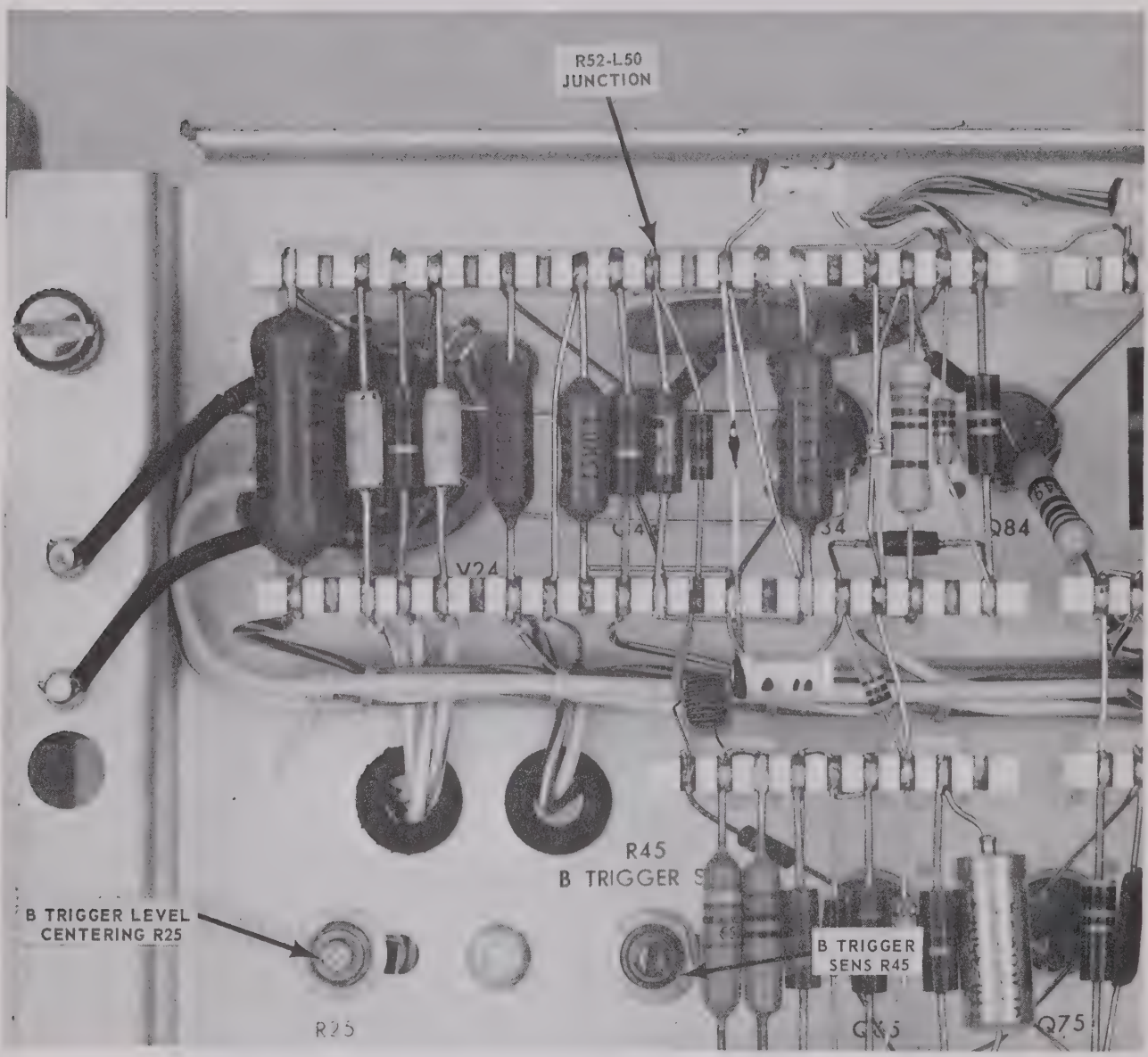



Fig. 2. B Trigger adjustment and test point locations.

| | |
|---|---|
| COUPLING | AC |
| SOURCE | EXT |

TU-7

| | |
|---|---|
| Variable | Fully Clockwise |
| Position | Centered |
| Test Function | Low Load |

Test Oscilloscope

| | |
|---|---|
| Input Coupling | AC |
| Volts/Div | .02 |
| Time/Div | .5 mSEC |
| Triggering | |
| Mode | AUTO |
| Slope | + |
| Coupling | AC |
| Source | Internal |

d. Locate the junction of R17, C18, R18 (See Fig. 2, page 6 of this modification). Connect a short jumper clip lead between the junction and ground. This jumper disables the B TRIGGERING LEVEL control.

e. Locate the junction of R52 and L50 (See Fig. 3, page 8 of this modification). Connect a 10X probe from the test oscilloscope to this junction.

f. Preset the B TRIGGER LEVEL CENTERING R25 control to midrange and the B TRIG SENS R45 fully clockwise.

g. Adjust the B TRIGGER LEVEL CENTERING R25 control for a stable display of square waves on the test oscilloscope. (The square waves will have an amplitude of approximately 200 mv peak-to-peak.) Note that there is a range in the adjustment of R25 through which the square wave will remain stable. Set R25 approximately in the middle of this range.

h. Change the SLOPE switch to -- and readjust R25 if necessary. Continue alternating the position of the

SLOPE switch and adjusting R25 until the square wave display on the test oscilloscope is stable in both positions of the SLOPE switch.

i. Turn the B TRIGGER SENS R45 control counterclockwise until the square wave display on the test oscilloscope just begins to break up. (This will occur where the square wave suddenly reduces in amplitude.) Leave R45 set at this point.

j. Readjust the B TRIGGER LEVEL CENTERING R25 control for a stable square wave display at both positions of the SLOPE switch. (Note that there is a range in the adjustment of the R25 over which a stable square wave can be obtained. Set R25 in the center of this range.)

k. Set the AMPLITUDE CALIBRATOR to 50 mVOLTS. The amplitude of the square wave display on the test oscilloscope should be reduced to less than 100 millivolts in either position of the SLOPE switch. If the amplitude of the square wave display on the test oscilloscope remains at approximately 200 millivolts, repeat steps i through k.

l. Disconnect the 10X probe from the junction of R52 and L50.

## PARTS LIST CORRECTIONS

REMOVE:

| | | | | | |
|---|---|---|---|---|---|
| C41 | 281-0523-00 | 100 pF | Cer | 350 V | ±20 pF |
| C43 | 281-0525-00 | 470 pF | Cer | 500 V | ±94 pF |
| C56 | 281-0576-00 | 11 pF | Cer | 500 V | 5% |
| C241 | 281-0523-00 | 100 pF | Cer | 350 V | ±20 pF |
| C243 | 281-0525-00 | 470 pF | Cer | 500 V | ±94 pF |
| C256 | 281-0576-00 | 11 pF | Cer | 500 V | 5% |
| L44 | 276-0507-00 | Core, Ferramic Suppressor | | | |
| L52 | 108-0147-00 | 2.2 µH | | | |
| L244 | 276-0507-00 | Core, Ferramic Suppressor | | | |
| L252 | 108-0147-00 | 2.2 µH | | | |
| R41 | 316-0221-00 | 220 Ω | 1/4 W | | |
| R43 | 316-0100-00 | 10 Ω | 1/4 W | | |
| R44 | 322-0001-00 | 10 Ω | 1/4 W | Prec | 1% |
| R47 | 324-0306-00 | 15 k | 1 W | Prec | 1% |
| R48 | 324-0306-00 | 15 k | 1 W | Prec | 1% |
| R241 | 316-0221-00 | 220 Ω | 1/4 W | | |
| R243 | 316-0100-00 | 10 Ω | 1/4 W | | |
| R244 | 323-0001-00 | 10 Ω | 1/2 W | Prec | 1% |
| R247 | 324-0306-00 | 15 k | 1 W | Prec | 1% |
| R248 | 324-0306-00 | 15 k | 1 W | Prec | 1% |

CHANGE TO:

| | | | | | |
|---|---|---|---|---|---|
| C76 | 290-0175-00 | 10 µF | EMT | 35 V | 20% |
| C276 | 290-0175-00 | 10 µF | EMT | 35 V | 20% |
| Q34, Q44 Q234, Q244 | 151-0199-00 | Silicon | MPS-3640 | | |
| R21 | 315-0471-00 | 470 Ω | 1/4 W | | 5% |
| R23 | 315-0471-00 | 470 Ω | 1/4 W | | 5% |
| R36 | 308-0320-00 | 15.6 k | 3 W | WW | 1% |

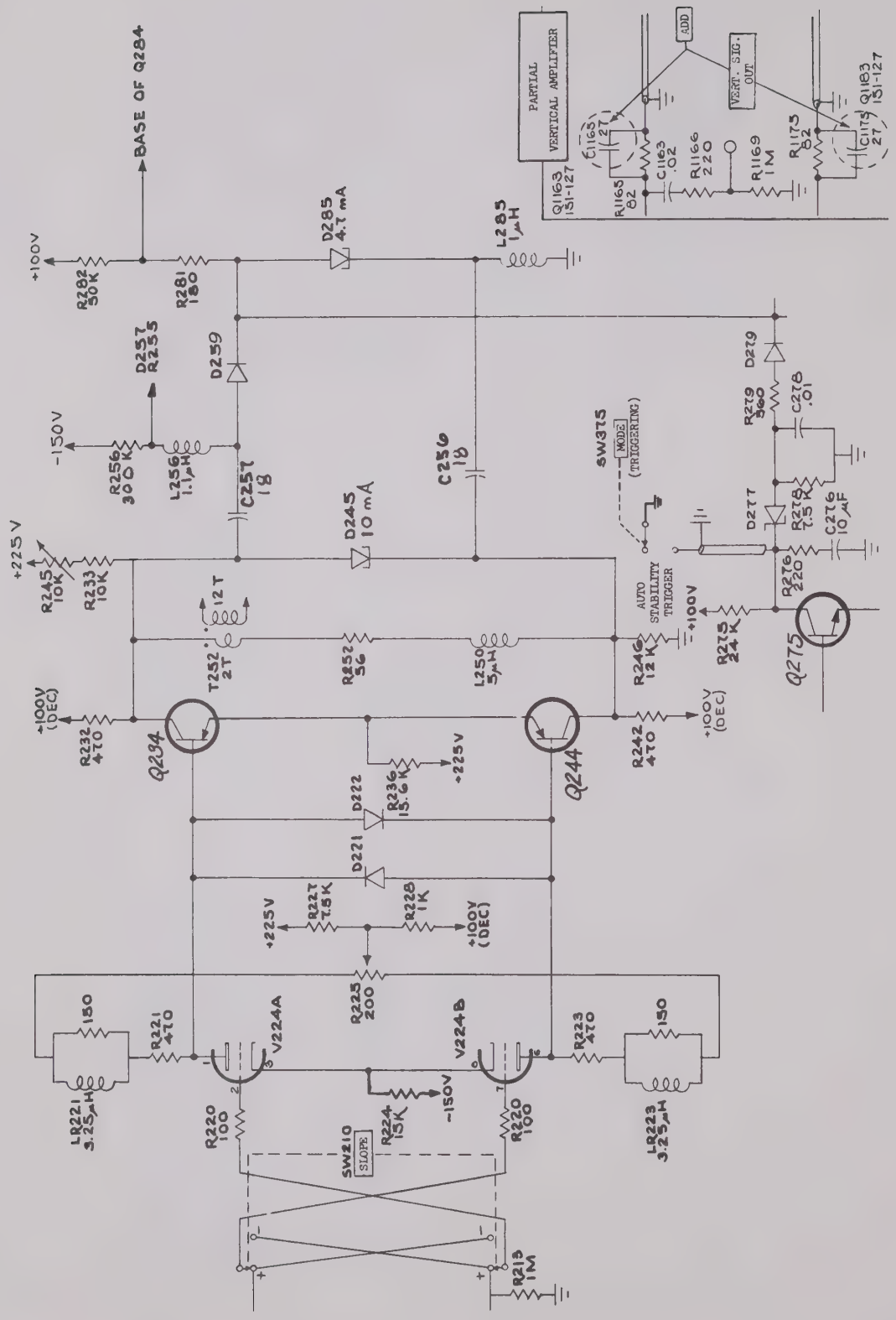
M12,027/767

| | | | | | | |
|---|---|---|---|---|---|---|
| R45 | 311-0405-00 | 10 k | | Var | | 5% |
| R57 | 302-0104-00 | 100 k | 1/2 W | | | 10% |
| R75 | 303-0243-00 | 24 k | 1 W | | | 5% |
| R76 | 301-0221-00 | 220 Ω | 1/2 W | | | 5% |
| R79 | 302-0561-00 | 560 Ω | 1/2 W | | | 10% |
| R81 | 315-0181-00 | 180 Ω | 1/4 W | | | 5% |
| R82 | 323-0636-00 | 50 k | 1/2 W | | Prec | 1% |
| R221 | 315-0471-00 | 470 Ω | 1/4 W | | | 5% |
| R223 | 315-0471-00 | 470 Ω | 1/4 W | | | 5% |
| R236 | 308-0320-00 | 15.6 k | 3 W | WW | | 1% |
| R245 | 311-0076-00 | 10 k | | Var | | 10% |
| R256 | 301-0304-00 | 300 k | 1/2 W | | | 5% |
| R275 | 303-0243-00 | 24 k | 1/2 W | | | 5% |
| R276 | 301-0221-00 | 220 Ω | 1/2 W | | | 5% |
| R279 | 302-0561-00 | 560 Ω | 1/2 W | | | 10% |
| R281 | 315-0181-00 | 180 Ω | 1/4 W | | | 5% |
| R282 | 323-0636-00 | 50 k | 1/2 W | | Prec | 1% |
| T52 | *120-0500-00 | 2T-12T Bifilar | | | | |
| T252 | *120-0500-00 | 2T-12T Bifilar | | | | |

ADD:

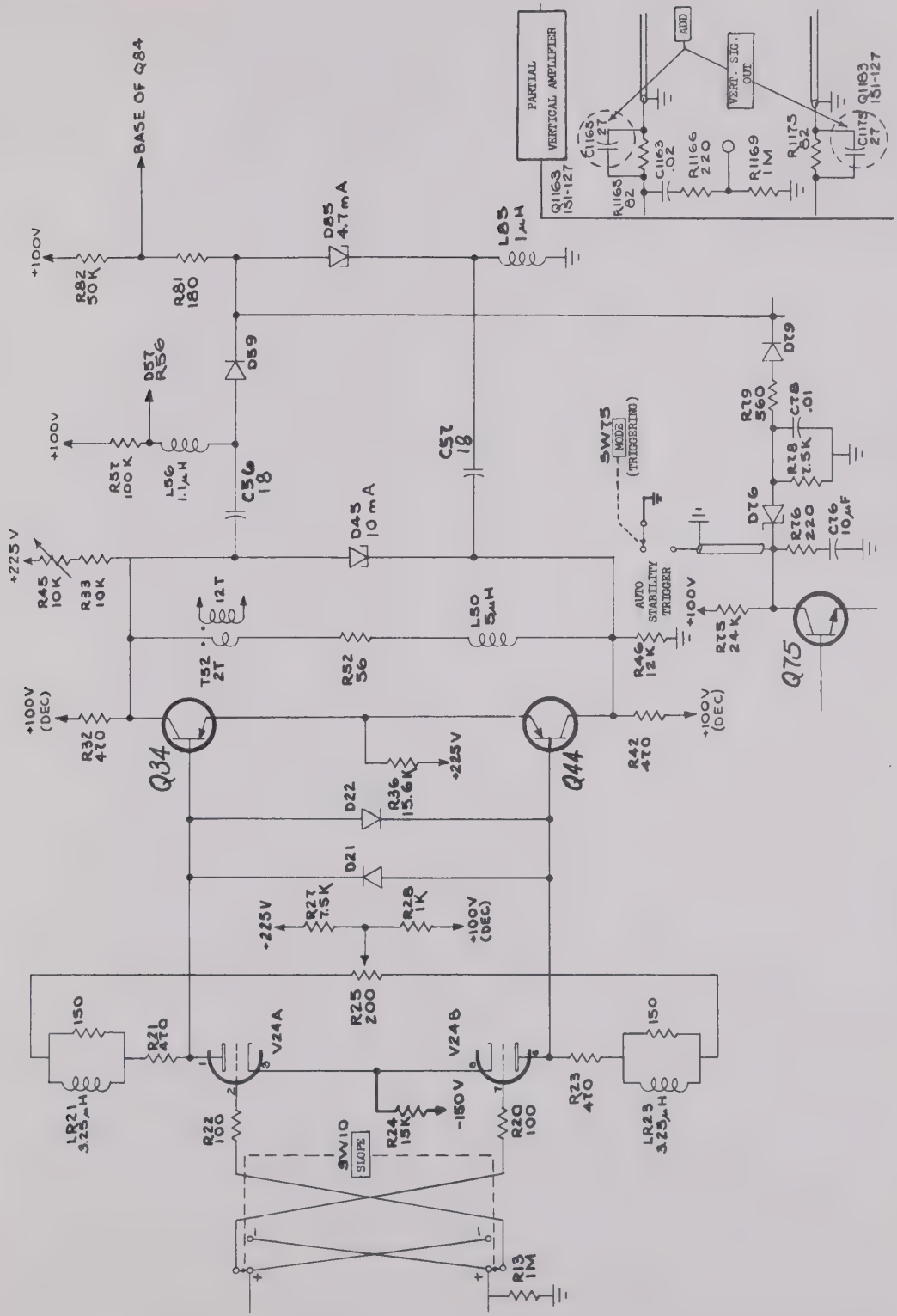
| | | | | | |
|---|---|---|---|---|---|
| C44, C45 C244, C245 | 281-0578-00 | 18 pF | Cer | 500 V | 5% |
| C56, C57 C256, C257 | 281-0578-00 | 18 pF | Cer | 500 V | 5% |
| C1165 | 281-0512-00 | 27 pF | Cer | 500 V | ±2.7 pF |
| C1175 | 281-0512-00 | 27 pF | Cer | 500 V | ±2.7 pF |
| D21 | 152-0075-00 | Germanium | 6075 | | |
| D22 | 152-0075-00 | Germanium | 6075 | | |
| D221 | 152-0075-00 | Germanium | 6075 | | |
| D222 | 152-0075-00 | Germanium | 6075 | | |
| L50 | 108-0146-00 | 5 µH | | | |
| L85 | 108-0410-00 | 1 µH | | | |
| L250 | 108-0146-00 | 5 µH | | | |
| L285 | 108-0410-00 | 1 µH | | | |

| | | | | | |
|---|---|---|---|---|---|
| R32 | 315-0471-00 | 470 Ω | 1/4 W | | 5% |
| R33 | 308-0301-00 | 10 k | 3 W | WW | 1% |
| R42 | 315-0471-00 | 470 Ω | 1/4 W | | 5% |
| R46 | 308-0310-00 | 12 k | 5 W | WW | 1% |
| R52 | 315-0560-00 | 56 Ω | 1/4 W | | 5% |
| R232 | 315-0471-00 | 470 Ω | 1/4 W | | 5% |
| R233 | 308-0301-00 | 10 k | 3 W | WW | 1% |
| R242 | 315-0471-00 | 470 Ω | 1/4 W | | 5% |
| R246 | 308-0310-00 | 12 k | 5 W | WW | 1% |
| R252 | 315-0560-00 | 56 Ω | 1/4 W | | 5% |




PARTIAL 'A' SWEEP TRIGGER

M12,027/767




PARTIAL 'B' SWEEP TRIGGER

M12,027/767

| | |
|---|---|
| TYPE 544/RM544 | TENT SN 1120 |
| TYPE 546 | TENT SN 1266 |
| TYPE RM546 | TENT SN 583 |
| TYPE 547 | TENT SN 8090 |
| TYPE RM547 | TENT SN 7980 |

# OPERATING INSTRUCTIONS

## Line Voltage Selection Switch

The voltage selector switch, shown in Fig. 1 provides a convenient means for adapting an instrument to a wide variety of line voltages, with 115 and 230 volts being nominal. Input circuit combinations are clearly displayed for visual examination on the voltage selector cover. The switch assembly provides additional connections in the primary of the power transformer that permits selection of one of three regulating ranges. Appropriate line fuses are automatically selected when changes are made.

To convert from one nominal line voltage to the other and/or change regulating ranges, use the following procedure.

1. DISCONNECT THE INSTRUMENT FROM THE POWER SOURCE.
2. Loosen two captive screws that hold the cover in the voltage selector switch base (see Fig. 1). Pull the cover straight away from the base to remove.
3. To change nominal voltage settings, pull out the voltage selector switch plug (see Fig. 1), rotate 180° in either direction and replace.
4. To change regulating ranges, pull out the range selector plug (see Fig. 1) and slide it Left or Right to the correct range, and replace. The range selector plug need not be rotated 180° as both sides of the guide are identical. The actual line voltage must be within the selected regulating range and preferably near the center of the selected regulating ranges (see Table 1).

5. Re-install the cover and tighten the two captive screws, making sure that the indicating tabs on both the range selector plug and regulating plug tabs protrude through the correct holes in the cover for the desired line voltage and regulating range.

6. Apply power.

CAUTION

Operation of this instrument with the Voltage Selector or Range Selector switch in the wrong position for the applied line voltage may damage the instrument or cause improper operation.

TABLE 1

| Range Selector switch position | Voltage Selector | |
|---|---|---|
| | 115 volts Nominal | 230 volts Nominal |
| | Regulating Range | |
| LO | 90 - 110 volts | 180 - 220 volts |
| M | 104 - 126 volts | 208 - 252 volts |
| HI | 112 - 136 volts | 224 - 272 volts |

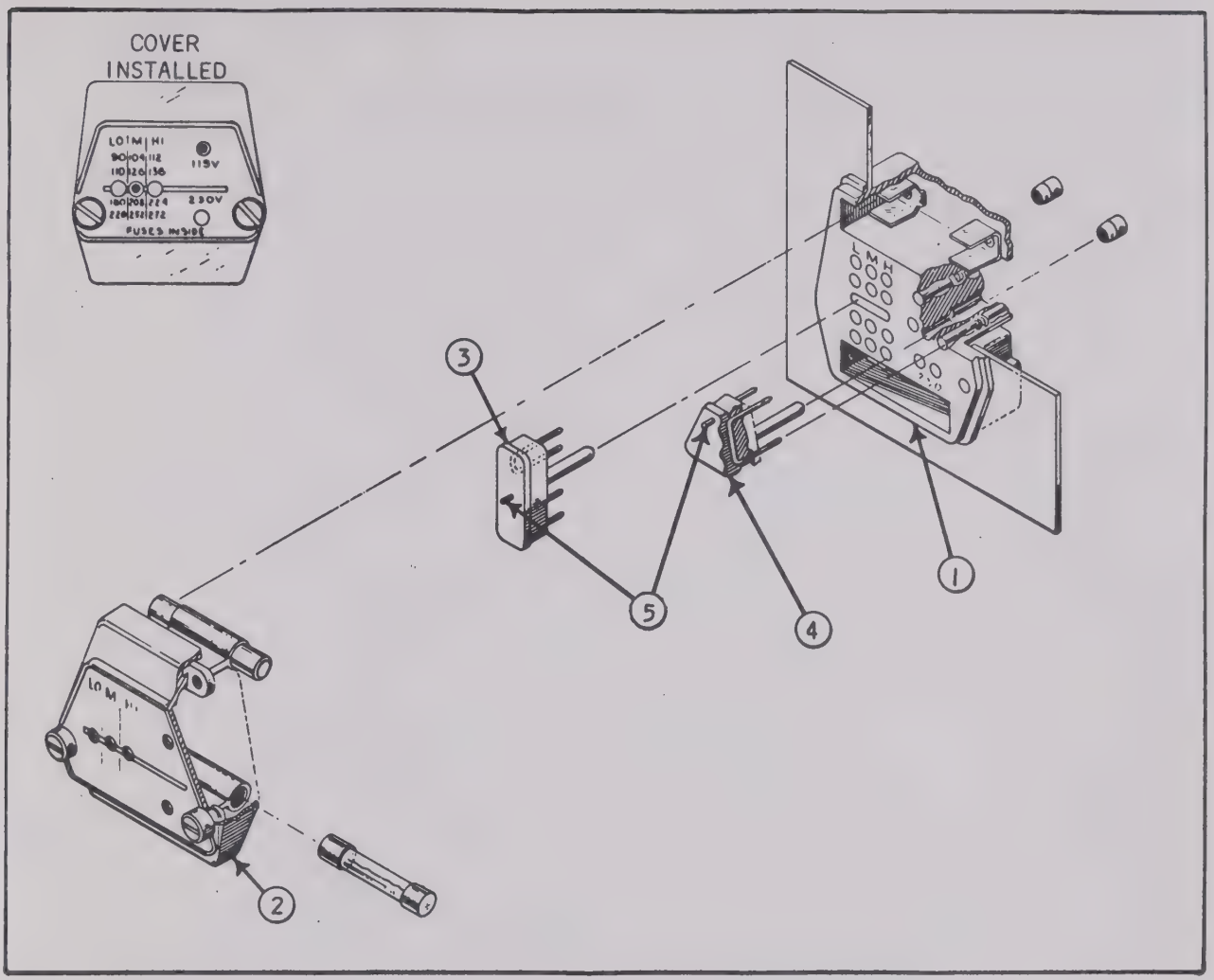



Figure 1. Voltage Selection Switch

1. Switch Body
2. Switch Cover
3. Range Selector Plug
4. Nominal Voltage Selector Plug
5. Indicating Tabs

## ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

| | | | |
|---|---|---|---|
| T601 | 120-0521-00 | Power | |
| SW601 | 260-0785-00 | Toggle | POWER ON |

ADD:

| | | | | |
|---|---|---|---|---|
| F602 | 159-0005-00 | 3 Amps | 3 AG | Slo-Blo, 230 V |
| SW602* | | | | |

*See Mechanical Parts List, Line Voltage Selector Body

## MECHANICAL PARTS LIST CORRECTION

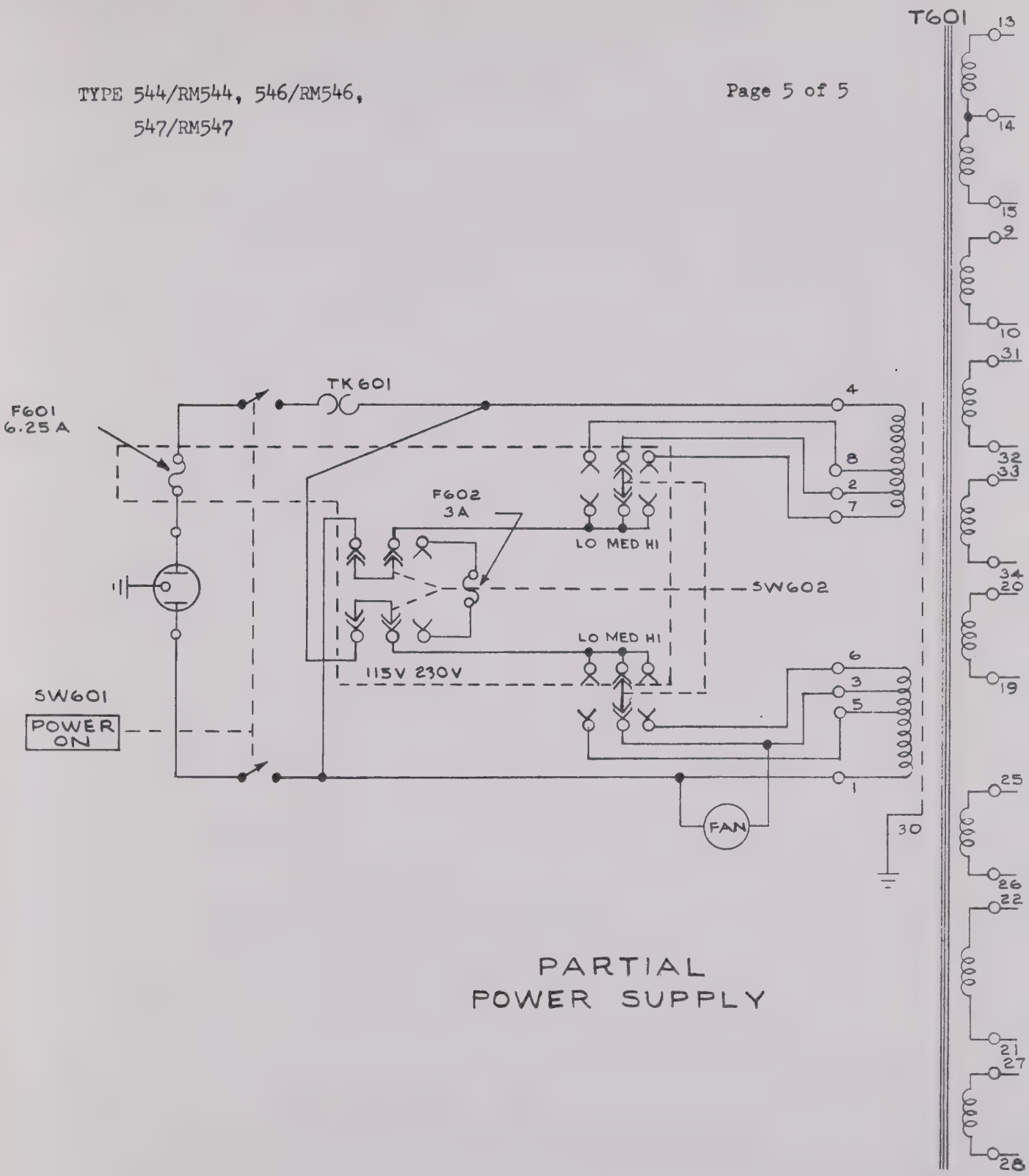
ADD:

| | |
|---|---|
| 204-0279-00 | 1 BODY, line voltage selector |
| 200-0704-00 | 1 COVER, line voltage selector |
| 200-0762-00 (for Rackmount instruments) | 1 COVER, line voltage selector |
| 161-0033-00 | 1 CORD, power |

Standard Accessories

REMOVE:

| | | |
|---|---|---|
| Ref No. 2 | 161-0010-03 | 1 CORD, power |




PARTIAL
POWER SUPPLY

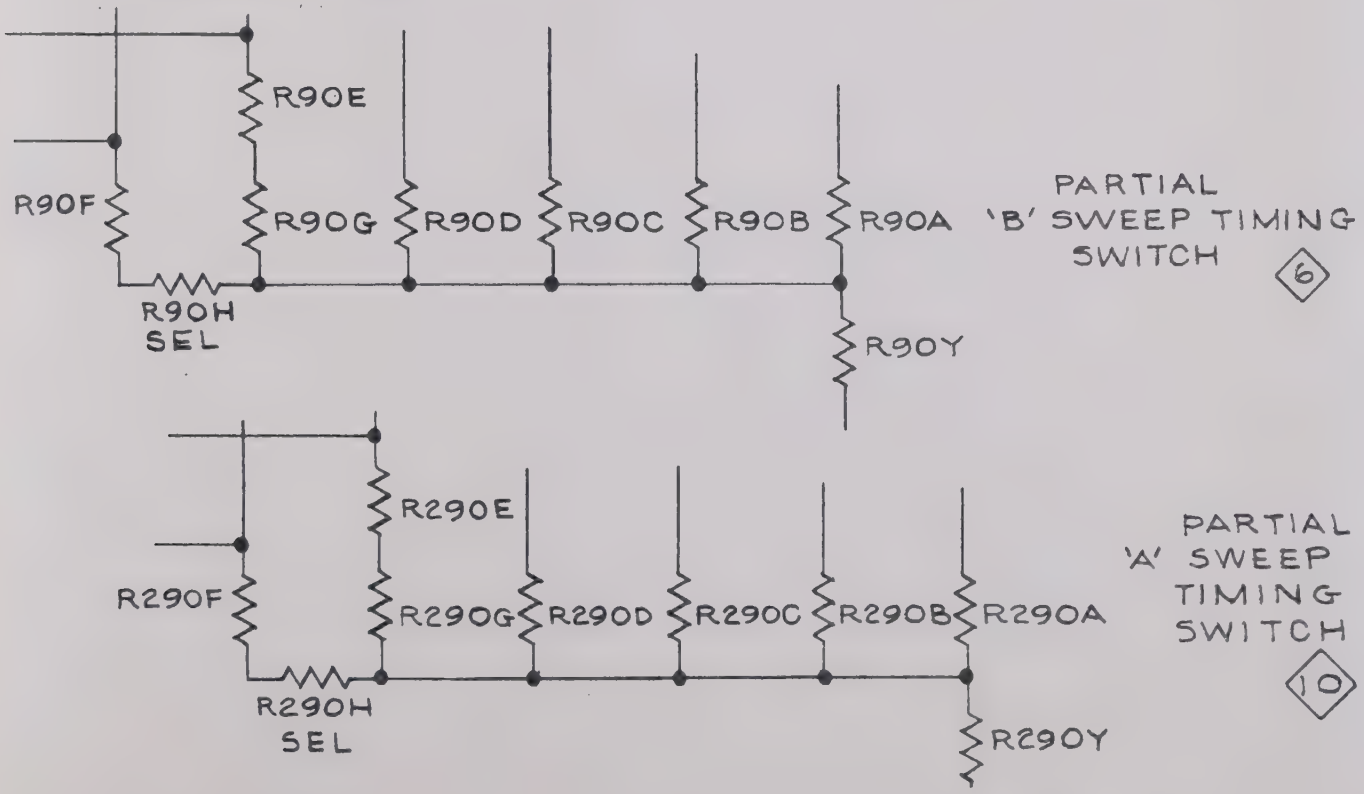
TYPE 546 /RM546 TENT SN 1370

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

| | | | | |
|---|---|---|---|---|
| R90D | | 1.4 meg | 1/2 W | 1% |
| R90E | | 2.8 meg | 1/2 W | 1% |
| R90F | 312-0641-02 | 7 meg | 1/2 W | 1% |
| R90G | | 47 k (nominal value) | | Selected |
| R90H | | 39 k (nominal value) | | Selected |
| R290D | | 1.4 meg | 1/2 W | 1% |
| R290E | | 2.8 meg | 1/2 W | 1% |
| R290F | 312-0641-02 | 7 meg | 1/2 W | 1% |
| R290G | | 47 k (nominal value) | | Selected |
| R290H | | 38 k (nominal value) | | Selected |

The part number is changed because of the addition of R90H, and R290H, see the schematic below.




M13,653/468

TYPE 546/RM546 TENT SN 1450

ELECTRICAL PARTS LIST CORRECTION

CHANGE TO:

| | | | | | |
|---|---|---|---|---|---|
| R964 | 323-0638-06 | 50 kΩ | 1/2 W | Prec | ¼% |
| R965 | 323-0637-06 | 50 kΩ | 1/2 W | Prec | ¼% |

M12,856/768